PARADISE DATACOM

Compact Outdoor
Solid State Power Amplifier
Operations Manual

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1.0 Introduction

This section provides the general information for the Paradise Datacom LLC line of Compact Outdoor Solid State Power Amplifiers. The Compact Outdoor SSPA has been designed and manufactured to be an extremely robust and reliable amplifier. It is well suited for harsh outdoor environments.

1.1 Description

The Compact Outdoor SSPA is a one-piece integrated Satcom amplifier system. It includes the AC/DC power supply, microwave amplifier module, microprocessor based monitor and control circuitry, and an efficient thermal management system.

The reduced size and weight of this amplifier system allow it to be used in a wide variety of installations; many of which historically precluded the use of Solid State power amplifiers. This amplifier is ideal for mounting on the boom of small antennas or anywhere that size and weight are a major concern.

Features include:

- Compact Size: 10.0 in x 19.5 in x 6.50 in. (254 mm x 495 mm x 165 mm)
- Very light weight: Base units weigh as little as 36 lb. (16.4 kg)
- Auto-Sensing Power Factor Corrected Power Supply
- RF Gain Adjustment: 55 dB to 75 dB minimum with 0.1 dB resolution
- Output Power Detection
- Output Power Sample Port
- Internal 1:1 Redundant Capability
- Optional L-Band Input Capability
- Serial (RS 232 / RS 485) or Parallel Monitor & Control Circuitry
- Windows Monitor & Control Software

1.2 Specifications

Refer to Appendix E for full specifications of the Compact Outdoor SSPA.

1.3 Equipment Supplied

The following equipment is supplied with each unit:

- The Compact Outdoor Amplifier Assembly;
- Prime power mating connector: AC - MS3106E20-3S; DC - MS3106F20-29S
- Quick Start Serial Communication Cable, L204133-2
- Product Guide CD with SSPA Monitor & Control Software
- M&C (J4) Mating Connector, MS3116F18-32P

- Waveguide gaskets (dependent on frequency band)
- Sealing tape (87F730)

1.4 Safety Considerations

Potential safety hazards exist unless proper precautions are observed when working with this unit. To ensure safe operation, the user must follow the information, cautions, and warnings provided in this manual as well as the warning labels placed on the unit itself.

1.4.1 High Voltage Hazards

Only qualified service personnel should service the internal electronic circuitry of the Compact Outdoor Amplifier. High DC voltages (300 VDC) are present in the power supply section of the amplifier. Care must be taken when working with devices that operate at this high voltage levels. It is recommended to never work on the unit or supply prime AC power to the unit while the cover is removed.

1.4.2 RF Transmission Hazards

RF transmissions at high power levels may cause eyesight damage and skin burns. Prolonged exposure to high levels of RF energy has been linked to a variety of health issues. Please use the following precautions with high levels of RF power.

- Always terminate the RF input and output connector prior to applying prime AC input power.
- Never look directly into the RF output waveguide
- Maintain a suitable distance from the source of the transmission such that the power density is below recommended guidelines in ANSI/IEEE C95.1. The power density specified in ANSI/IEEE C95.1-1992 is 10 mW/cm^2. These requirements adhere to OSHA Standard 1910.97.
- When a safe distance is not practical, RF shielding should be used to achieve the recommended power density levels.

2.0 Introduction

This section provides information for the initial inspection, installation, external connections, and shipment of the Compact Outdoor SSPA unit.

2.1 Inspection

When the unit is received, an initial inspection should be completed. First ensure that the shipping container is not damaged. If it is, have a representative from the shipping company present when the container is opened. Perform a visual inspection of the Compact Outdoor Amplifier to make sure that all items on the packing list are enclosed. If any damage has occurred or if items are missing, contact:

Paradise Datacom LLC
328 Innovation Park
State College, PA 16803

Phone: 1 (814) 238-3450
Fax: 1 (814) 238-3829

2.2 Prime Power Connection [MS3102E20-3P]

The Prime power connector is a 3-pin circular connector, J7. The power supplies provide universal AC input by using auto-sensing power supplies. The AC input can operate over a range of 90-265 VAC, at 47 to 63 Hz. The power supply is also power factor corrected, enabling the unit to achieve a power factor greater than 0.93.

The highest output power levels, >70 W @ Ku-Band and >100 W @ C-Band should be powered only from a 180–265 VAC source. This will keep AC line currents to safe operating levels for the internal EMI filter and associated circuitry. The AC Line input connector configuration is given in Table 2-1. The prime power vs. RF output power is summarized in Table 2-2. An option for 110 VAC prime power is available for the higher-powered units.

Table 2-1: AC Line Input Connector

J7 Pin	Connection
A	L1
B	GND
C	L2/N

Table 2-2: Compact Outdoor Amplifier Prime Power Summary

Band	Model	RF Output Power	AC Input Voltage	AC Input Power
		P_{sat} / P_{1dB}	Operating Range	Maximum
C-Band 5.850 - 6.425 GHz	HPAC2030ACXXXXX	45.0/44.8 dBm	90 – 265 vac	250 W
	HPAC2040ACXXXXX	46.0/45.8 dBm	90 – 265 vac	300 W
	HPAC2050ACXXXXX	47.0/46.8 dBm	90 – 265 vac	400 W
	HPAC2075ACXXXXX	48.8/48.5 dBm	90 – 265 vac	450 W
	HPAC2100ACXXXXX	50.0/49.5 dBm	90 – 265 vac	700 W
	HPAC2140ACXXXXX	51.5/51.0 dBm	180 – 265 vac*	850 W
	HPAC2200ACXXXXX	53.0/52.3 dBm	180 – 265 vac*	1000 W
	HPAC2250ACXXXXX	53.9/53.0 dBm	180 – 265 vac*	1300 W
	HPAC2300ACXXXXX	54.7/54.0 dBm	180 – 265 vac*	1700 W
Ku-Band 14.000 - 14.500 GHz	HPAK2010ACXXXXX	40.0/39.0 dBm	90 – 265 vac	220 W
	HPAK2020ACXXXXX	43.0/42.0 dBm	90 – 265 vac	250 W
	HPAK2025ACXXXXX	44.0/43.0 dBm	90 – 265 vac	320 W
	HPAK2035ACXXXXX	45.5/44.5 dBm	90 – 265 vac	350 W
	HPAK2040ACXXXXX	46.0/45.0 dBm	90 – 265 vac	550 W
	HPAK2050ACXXXXX	47.0/46.0 dBm	90 – 265 vac	600 W
	HPAK2070ACXXXXX	48.5/47.5 dBm	90 – 265 vac	650 W
	HPAK2100ACXXXXX	50.0/49.0 dBm	180 – 265 vac*	1000 W
	HPAK2125ACXXXXX	51.0/50.0 dBm	180 – 265 vac*	1150 W
	HPAKG200ACXXXXX◊	52.5 dBm (P_{3dB})	90 – 265 vac	1910 W
X-Band 7.900 - 8.400 GHz	HPAX2060ACXXXXX	47.5/47.3 dBm	90 – 265 vac	650 W
	HPAX2075ACXXXXX	48.8/48.3 dBm	90 – 265 vac	700 W
	HPAX2100ACXXXXX	50.0/49.5 dBm	90 – 265 vac	750 W
	HPAX2140ACXXXXX	51.4/50.8 dBm	180 – 265 vac	1225 W
	HPAX2200ACXXXXX	53.0/51.8 dBm	180 – 265 vac*	1370 W
	HPAX2250ACXXXXX	54.0/53.0 dBm	180 – 265 vac*	1550 W
	HPAXG400ACXXXXX◊	56.0 dBm (P_{3dB})	90 – 265 vac	2000 W
S-Band 2.020 - 2.120 GHz (unless otherwise indicated)	HPAS2050ACXXXXX	47.5/47.0 dBm	90 – 265 vac	425 W
	HPAS2100ACXXXXX	50.5/50.0 dBm	90 – 265 vac	650 W
	HPAS2200ACXXXXX**	53.5/53.0 dBm	180 – 265 vac*	1000 W
	HPAS2200ACXXXXX***	53.0/52.5 dBm	180 – 265 vac*	1000 W
	HPAS2300ACXXXXX**	55.0/54.5 dBm	180 – 265 vac*	1600 W
	HPAS2300ACXXXXX***	54.4/54.0 dBm	180 – 265 vac*	1600 W
	HPAS2050BCXXXXX@	47.5/47.0 dBm	90 – 265 vac	425 W
	HPAS2100BCXXXXX@	50.5/50.0 dBm	90 – 265 vac	650 W
	HPAS2200BCXXXXX@	53.5/53.0 dBm	180 – 265 vac*	1000 W
	HPAS2300BCXXXXX@	55.0/54.5 dBm	180 – 265 vac*	1600 W
Ka-Band 30.0 - 31.0 GHz	HPAKA020ACXXXXX	43.0/-- dBm	90 – 265 vac	280 W
	HPAKA040ACXXXXX	46.0/-- dBm	90 – 265 vac	520 W

* Optional 110 vac operation available; ** 2.020 - 2.090 GHz; *** 2.095 - 2.120 GHz @ 2.200 - 2.300 GHz ◊ GaN module (P_{3dB} only)

2.3 DC Input Option [MS3102E-20-29P]

The Compact Outdoor Amplifier can also be configured with a DC Input Voltage power supply. The DC Input Voltage can range from 42-60 VDC. When using a DC input voltage the input power connector, J7, is configured per Table 2-3.

Table 2-3: DC Input Connector, MS3102E-20-29P

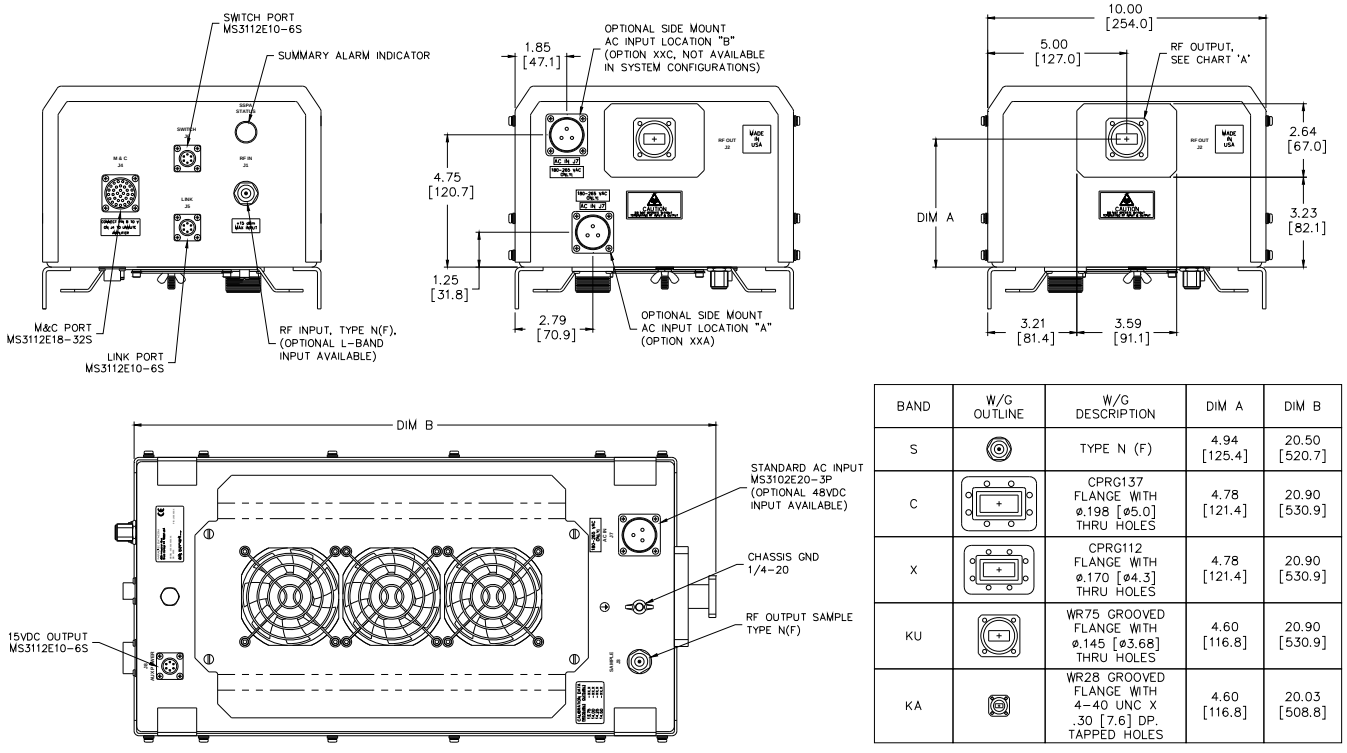
Pin # on J7	Connection	Pin # on J7	Connection
B	+48 V	L	-48 V
C	+48 V	M	-48 V
D	+48 V	N	GND
K	-48 V		

2.4 Summary Alarm Indicator

A summary alarm indicator LED is located on the input side of the amplifier. When the SSPA is online, this indicator illuminates GREEN. When in a fault condition, it illuminates RED.

2.5 Cable Connections

Figure 2-1 shows the dimensioned outline of the Compact Outdoor Amplifier, displaying the connector locations. The connector locations can be found in Figures 2-2 through 2-4.



BAND	W/G OUTLINE	W/G DESCRIPTION	DIM A	DIM B
S		TYPE N (F)	4.94 [125.4]	20.50 [520.7]
C		CPRG137 FLANGE WITH ø.198 [ø5.0] THRU HOLES	4.78 [121.4]	20.90 [530.9]
X		CPRG112 FLANGE WITH ø.170 [ø4.3] THRU HOLES	4.78 [121.4]	20.90 [530.9]
KU		WR75 GROOVED FLANGE WITH ø.145 [ø3.68] THRU HOLES	4.60 [116.8]	20.90 [530.9]
KA		WR28 GROOVED FLANGE WITH 4-40 UNC X .30 [7.6] DP. TAPPED HOLES	4.60 [116.8]	20.03 [508.8]

Figure 2-1: Outline, Compact Outdoor Solid State Amplifier

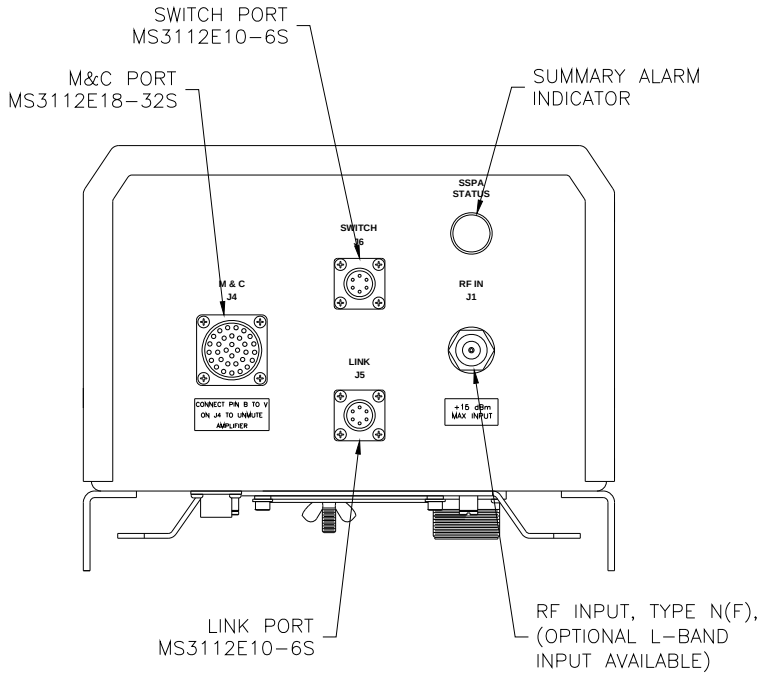


Figure 2-2: Input Side, Compact Outdoor Amplifier

Figure 2-2 shows the input side of the Compact Outdoor Amplifier. This side contains the RF input (J1), M&C input (J4), and the Interface connections (J5, J6).

2.5.1 RF Input (J1) [N-type (F)]

The RF Input connector is a type N female connector. Nominal RF input levels are approximately -28 dBm depending on the output power level of the unit. The maximum allowable RF input signal should be limited to +15 dBm.

2.5.2 Monitor & Control Connector (J4) [MS3112E18-32S]

The M&C, Monitor and Control, connector is the primary input for controlling the amplifier and monitoring fault conditions. It is a 32-pin circular connector, MS3112E18-32S. It requires a mating connector, MS3116F18-32P, which is supplied with the unit. The pin-out for this connector is described in Table 3-1.

2.5.3 Link Port (J5) [MS3112E10-6S]

The interface connector is used to connect between two Compact Outdoor Amplifiers when used in a 1:1 redundant system. It is a 6 pin circular connector, MS3112E10-6S. It requires a mating connector, MS3116F10-6P. A link cable is provided with a 1:1 Redundancy Kit which can be purchased separately. See Table 2-4.

Table 2-4: Link Port (J5) Pin-Outs

Pin # on J5	Connection	Pin # on J5	Connection
A	LINK OUT	D	N/C
B	LINK IN	E	N/C
C	N/C	F	GND

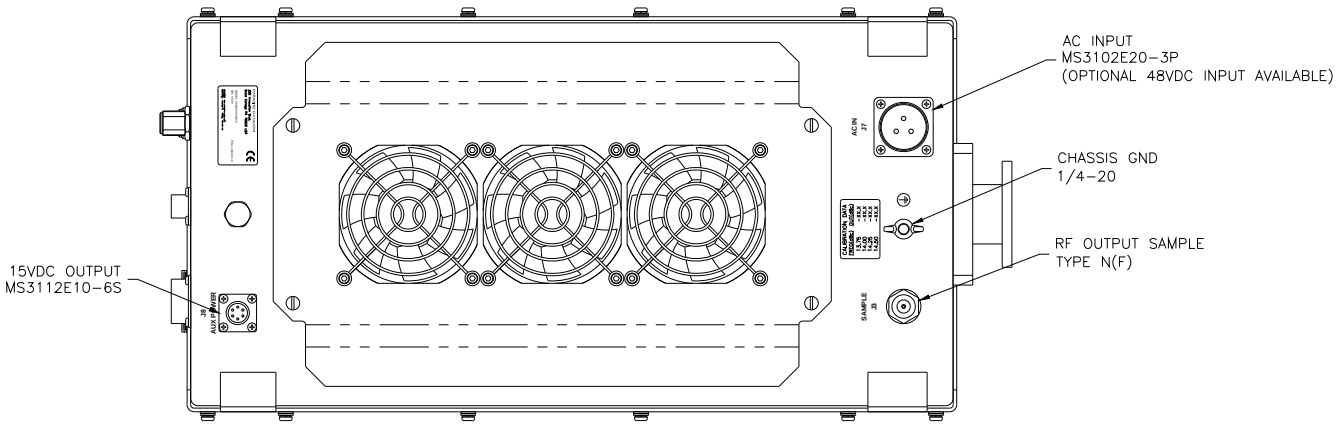


Figure 2-3: Bottom View, Compact Outdoor Amplifier

2.5.4 RF Output Sample Port (J3) [N-type (F)]

The RF Output Sample port, J3, is located on the bottom of the amplifier as shown in Figure 2 -3. This connector provides a -40 dBc sample of the amplifier's output signal. It is a N-type female connector.

2.5.5 Switch Port (J6) [MS3112E10-6S]

When used in a 1:1 redundant system, the waveguide switch must be connected to the switch port of each amplifier (MS3112E10-6S). See Table 2-5.

Table 2-5 Switch Port (J6) Pin-Outs

Pin # on J6	Connection	Pin # on J6	Connection
A	N/C	D	N/C
B	N/C	E	POS 2
C	+28 VDC	F	POS 1

2.5.6 15 VDC Output Port (J8) [MS3112E10-6S]

The 15 VDC Output, J8, is located on the bottom side of the amplifier as shown in Figure 2-3. This provides +15 VDC and up to 1 Amp current to any external equipment. It is a 6-pin MS-type connector. See Table 2-6.

Table 2-6: +15 VDC Output Port (J8) Pin-Outs

Pin # on J8	Connection	Pin # on J8	Connection
A	EXTERNAL FAULT IN	D	GND
B	FAULT PULLUP	E	+15V EXTERNAL
C	+15V LNA	F	GND

2.5.7 Chassis Ground Terminal

A Chassis ground terminal is provided on the bottom side of the amplifier. A ¼ - 20 threaded terminal is provided for equipment grounding.

2.5.8 AC Input (J7)

The AC Input connector, J7, is located on the bottom side of the Compact Outdoor Amplifier package. There are also two alternate placements for this connector on the RF Output end of the amplifier as shown in Figure 2-4. This connector is a 3-pin circular connector, MS3102E20 -3P. The mating connector (MS3106E20-3S) is shipped with the unit. The pin out for this connector is given in Table 2-1.

2.5.9 RF Output (J2)

The RF Output is brought out through waveguide in the Compact Outdoor Amplifier. Figure 2-4 shows the output of a C-Band Compact Outdoor Amplifier. The Ku-Band amplifiers have a WR75 grooved flange, while the C-Band and X-Band amplifiers have CPR style grooved flanges (CPRG-137 for C-Band; CPRG-112 for X-Band). Ka-Band amplifiers utilize a WR28 grooved flange. S-Band units are fitted with Type N (F) connectors at the RF Output.

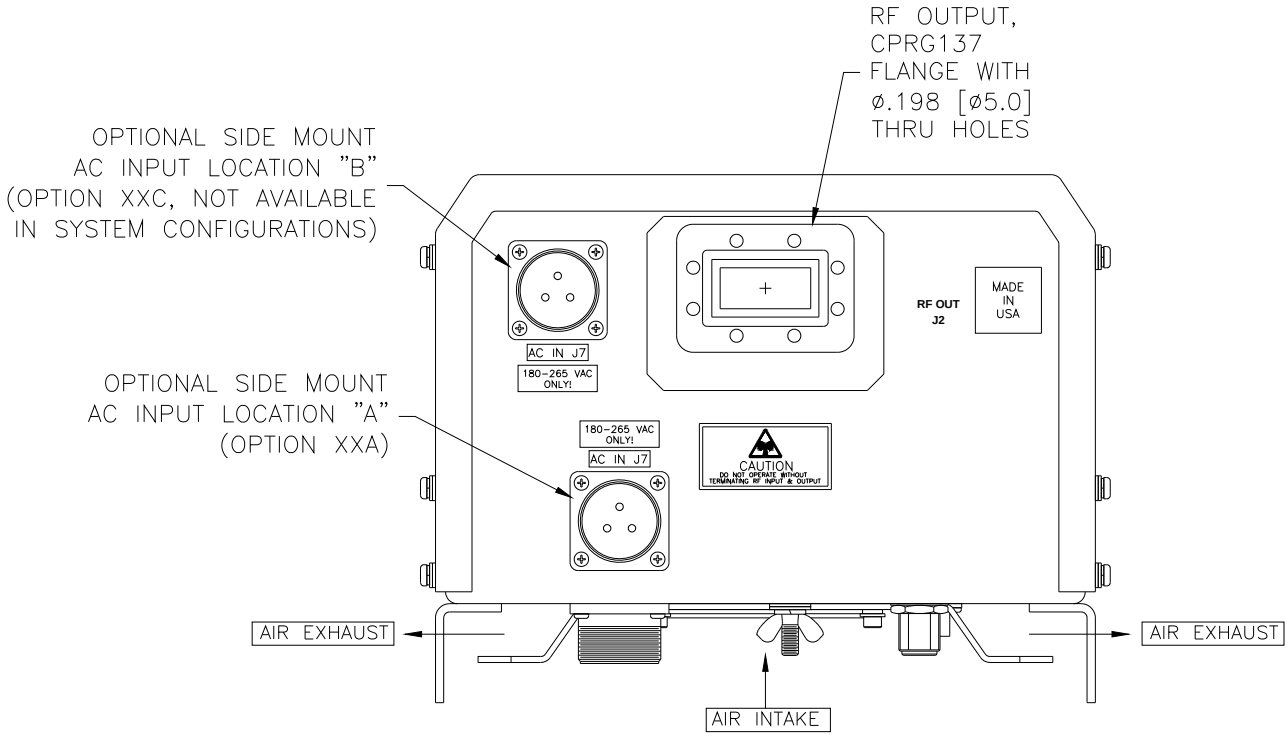


Figure 2-4: RF Output Side of C Band Compact Outdoor SSPA

An isolator is provided at the output flange with a termination capable of handling full reflected output power.

2.6 Airflow

The air intake and exhaust are both located on the bottom side of the amplifier. The intake is brought through three fans while the exhaust is along the two rows of heat sink fins as seen in Figure 2-4. A minimum clearance of 6 inches (152 mm) should be maintained between the fans and any surface during operation. This will ensure that there is no forced re-circulation of airflow from exhaust to intake. **The Compact Outdoor SSPA should NEVER be mounted with the fans facing up.**

2.7 Fiber-Optic Option

The Compact Outdoor Solid State Power Amplifier is available with an external fiber-optic conversion box. This configuration requires the addition of a 1RU RCPF-1000 Fiber Optic Control Panel. The Fiber-Optic Option is not available in S-Band units.

2.7.1 RCPF-1000 Fiber Optic Controller

The RCPF-1000 Fiber Optic Controller provides easy remote monitor and control of the Compact Outdoor SSPA with integral or external fiber-optic interface. Control of the RCPF-1000 can be handled through front panel operation or remotely via parallel or serial communication to a remote computer running Paradise Datacom's Universal M&C software.

The RCPF-1000 front panel includes 10 LEDs that indicate the internal state of the Compact Outdoor SSPA. Five fault condition LEDs on the left side of the front panel indicate any SSPA major faults, in addition to a summary fault state.

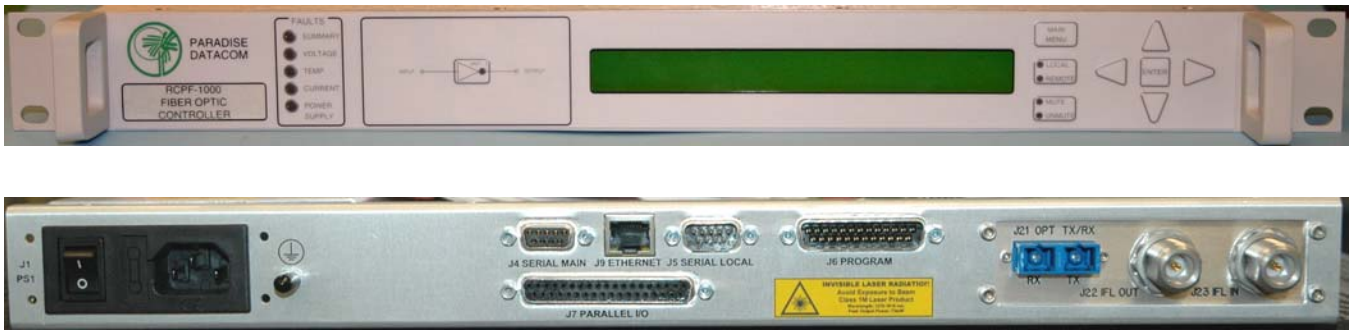


Figure 2-5: RCPF-1000 front, rear panels

A 2 line by 40 character LCD provides an extremely user friendly interface. Virtually all of the controller's setup and adjustments are accessible from the LCD. Four navigation buttons and a separate Enter key allow the user to navigate the firmware menu on the LCD. Separate buttons have been provided for frequently used functions. A range of RF hardware options is offered to meet specific system requirements.

The rear panel features ports for Serial Main (J4), Serial Local (J5) and Parallel I/O connections, as well as N-type connectors for L-Band Tx and Rx paths, and FC/APC connectors for Fiber Tx and Rx paths.

A complete description of the operation of the RCPF-1000 Fiber Optics Controller can be found in its operations manual, Paradise Datacom document number 204640.

2.7.2 External L-Band to Fiber Interface

The External L-Band to Fiber Interface is a machined aluminum watertight enclosure, with N-type connectors for L-Band RX and TX and fiber-optic connectors for the Fiber TX and RX signals. The enclosure is powered via a +15 VDC Input port connected to a Compact Outdoor SSPA's 15VDC Output port (J8). An outline drawing of the enclosure is shown in Figure 2-6.

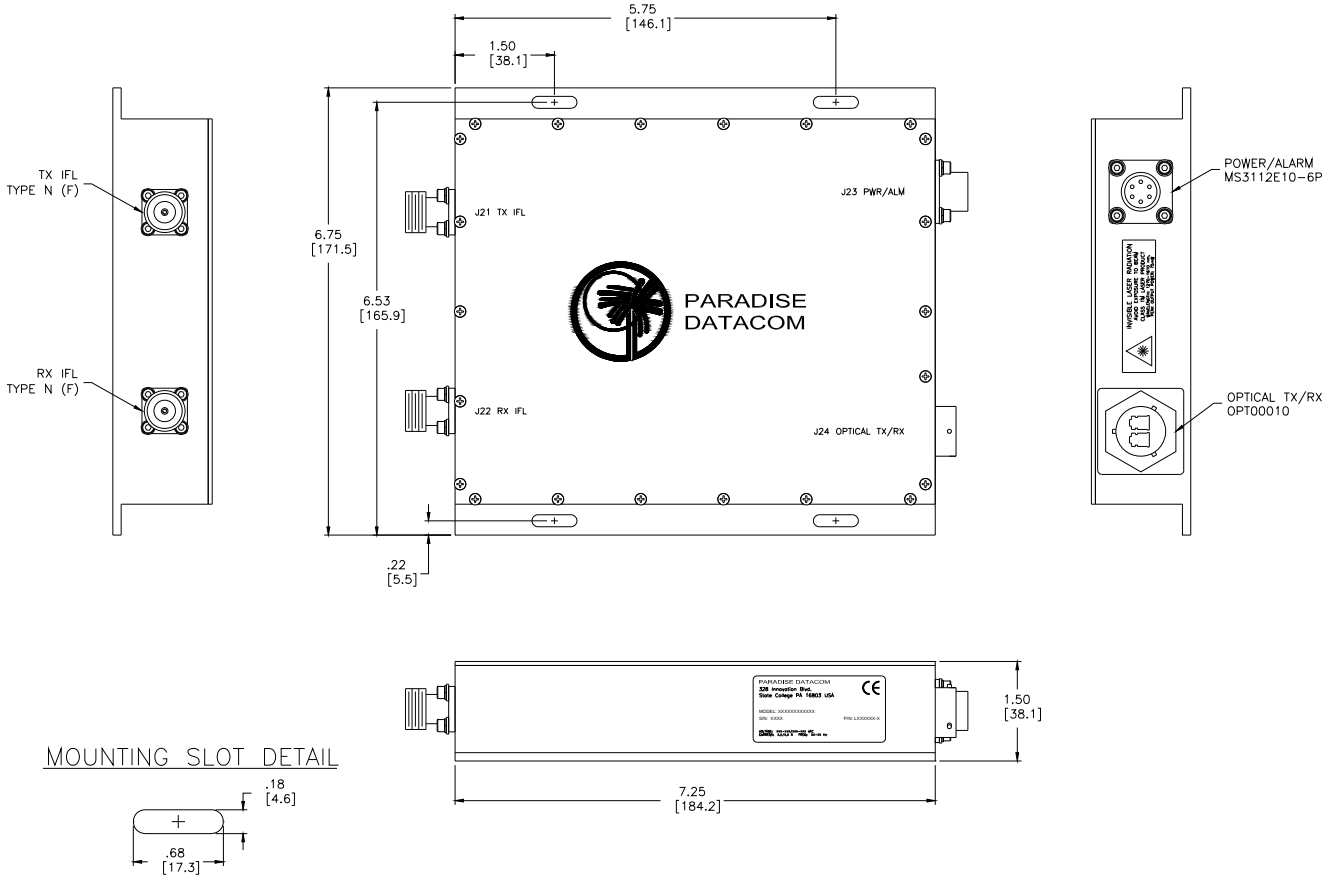


Figure 2-6: Outline Drawing, External L-Band to fiber interface

The OFM-1000 external interface allows connection between a Paradise Datacom Compact Outdoor SSPA with integrated Block Up Converter and a RCPF-1000 Fiber-Optic Control Panel via a fiber-optic cable run.

Figure 2-7: OFM-1000

Figure 2-8 shows a block diagram of a Compact Outdoor SSPA with an external L-Band to fiber enclosure connected to a RCPF-1000 controller.

Figure 2-9 shows an example of a transceiver system utilizing an Evolution Series L-Band modem, an RCPF-1000 fiber-optic controller, an external fiber to L-Band converter and a Compact Outdoor SSPA with integral ZBUC. This example allow an optional connection to a remote PC via RS-485, RS-232 or 10Base-T Ethernet connection.

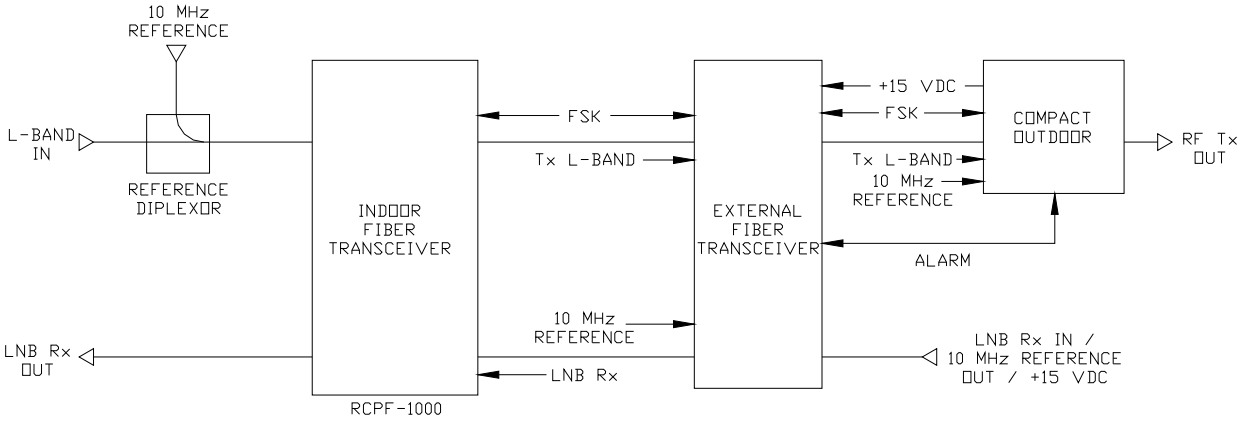


Figure 2-8: Block Diagram, Compact Outdoor with external fiber transceiver

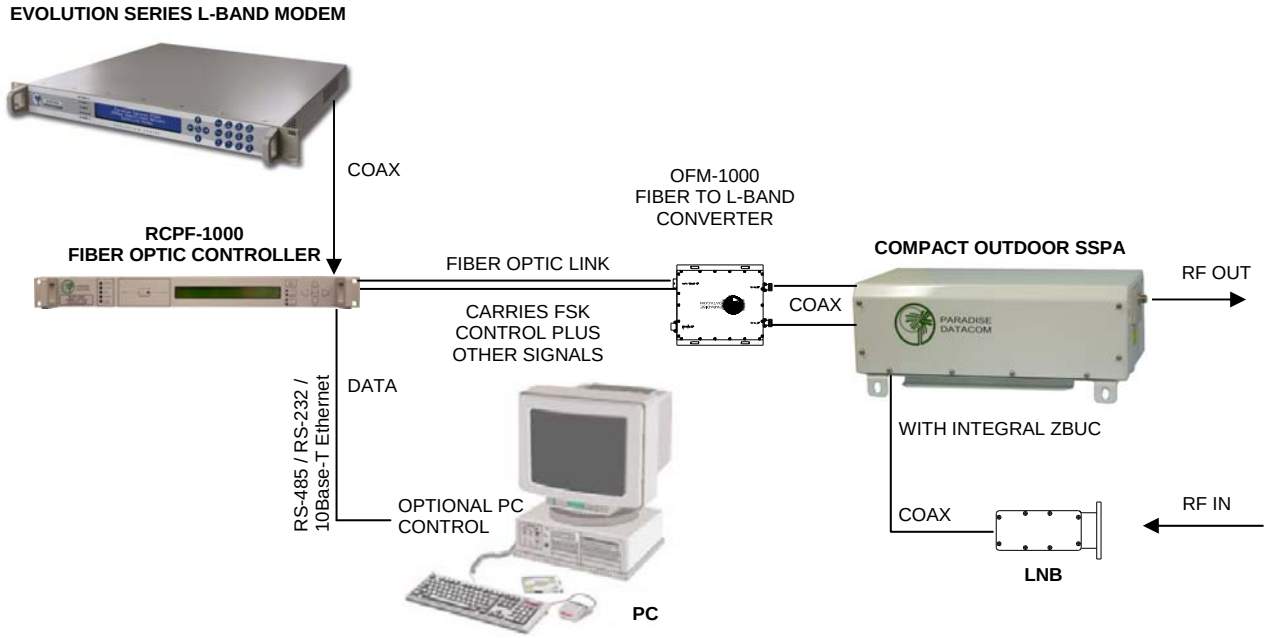


Figure 2-9: System example, SSPA with External Fiber to L-Band Converter

2.8 Unit Weights

The Compact Outdoor SSPA is available in a variety of frequency bands and power levels, and have a multitude of options which makes each unit weigh slightly different from another.

The following chart, Table 2-7, outlines the weights for the most common power levels of Compact Outdoor SSPA.

Table 2-7: Compact Outdoor SSPA Weights

Band	Model	Base Weight lbs (kg)	With zBUC lbs (kg)	With 110 VAC Option lbs (kg)
C-Band	HPAC2030AC...	36.5 (16.6)	+1.7 (+0.8)	N/A
	HPAC2040AC...	36.5 (16.6)	+1.7 (+0.8)	N/A
	HPAC2050AC...	36.5 (16.6)	+1.7 (+0.8)	N/A
	HPAC2075AC...	36.5 (16.6)	+1.7 (+0.8)	N/A
	HPAC2100AC...	36.8 (16.7)	+1.7 (+0.8)	N/A
	HPAC2140AC...	37.0 (16.8)	+1.7 (+0.8)	+1.9 (+0.9)
	HPAC2200AC...	37.8 (17.2)	+1.7 (+0.8)	+1.2 (+0.6)
	HPAC2250AC...	45.4 (20.6)	+1.7 (+0.8)	+1.2 (+0.6)
	HPAC2300AC...	46.9 (21.3)	+1.7 (+0.8)	N/A
Ku-Band	HPAK2010AC...	35.1 (16.0)	+1.7 (+0.8)	N/A
	HPAK2020AC...	35.1 (16.0)	+1.7 (+0.8)	N/A
	HPAK2025AC...	35.1 (16.0)	+1.7 (+0.8)	N/A
	HPAK2035AC...	35.1 (16.0)	+1.7 (+0.8)	N/A
	HPAK2040AC...	35.3 (16.1)	+1.7 (+0.8)	N/A
	HPAK2050AC...	35.7 (16.2)	+1.7 (+0.8)	N/A
	HPAK2070AC...	35.7 (16.2)	+1.7 (+0.8)	N/A
	HPAK2100AC...	42.5 (19.3)	+1.7 (+0.8)	+1.2 (+0.6)
	HPAK2125AC...	42.5 (19.3)	+1.7 (+0.8)	+1.2 (+0.6)
X-Band	HPAX2060AC...	46.3 (21.1)	+1.7 (+0.8)	N/A
	HPAX2075AC...	46.7 (21.2)	+1.7 (+0.8)	N/A
	HPAX2100AC...	46.7 (21.2)	+1.7 (+0.8)	N/A
	HPAX2140AC...	47.5 (21.6)	+1.7 (+0.8)	+1.2 (+0.6)
	HPAX2200AC...	54.9 (25.0)	+1.7 (+0.8)	+1.2 (+0.6)
	HPAX2250AC...	56.4 (25.6)	+1.7 (+0.8)	N/A
S-Band	HPAS2050AC...	36.0 (16.4)	N/A	N/A
	HPAS2100AC...	36.0 (16.4)	N/A	N/A
	HPAS2200AC...	44.0 (20.0)	N/A	N/A
	HPAS2300AC...	44.0 (20.0)	N/A	N/A
Ka-Band	HPAKA020AC…	44.3 (20.2)	+1.7 (+0.8)	N/A
	HPAKA040AC...	44.3 (20.2)	+1.7 (+0.8)	N/A

2.9 Compact Outdoor Mounting Kit Installation

These instructions outline how to install a single Paradise Datacom Compact Outdoor SSPA unit onto an antenna boom using a Universal Compact Outdoor Mounting Kit. This kit allows installation of the Compact Outdoor SSPA on antenna booms up to 10” thick.

2.9.1 Safety Considerations

These instructions are designed to be used by a single operator. As such, several safety issues should be kept in mind during the installation.

1. The Paradise Datacom Compact Outdoor SSPA unit weighs approximately 36 lbs., and should be handled with care to avoid scratching the exterior coating and compromising the unit’s corrosion resistance.
2. All bolts should be torqued down to within reasonable limits to avoid stripping the threads.
3. The section of antenna boom the unit is to be mounted on should be straight, dry, and free from corrosion or defects.

2.9.2 Inspection

On receiving the Universal Compact Outdoor Mounting Kit, inspect the contents to ensure all parts are present. The kit should contain all items shown in Table 2-8.

Table 2-8: Compact Outdoor SSPA Mounting Kit

Item #	Qty	Description	Part No.
1	4	Bracket, Mounting	L201394-1
2	4	Uni-Strut, 13.5” Lengths	L201393-1
3*	4	1/2”-13 All Thread Stud, SS	188FTS 8-11 or -15
4	4	1/2” Lock Washer	50LW188
5	16	Nut, Hex, 1/2”-13	1/2-13 Nut
6	16	Washer, Flat, Std. 1/2”	MS15795-819
7	4	Bolt, Hex, 1/2”-13 x 1.25, SS	MS35307-411

* Kits are supplied with two different All Thread lengths (11.0” or 15.0”) depending on the installation. The 11-inch All Thread (part no. 188FTS 8-11) allows mounting on booms up to 6” diameter. The 15-inch All Thread (part no. 188FTS 8-15) allows mounting on booms up to 10” diameter.

2.9.3 Installation

1. Locate the mounting studs on the bottom of the Compact Outdoor SSPA unit. Using a **½" bolt**, two **flat washers**, and a **½" nut**, firmly bolt one **mounting bracket** to each mounting stud, as shown in Figure 2-10. Be sure each bracket is vertical, and the top flange of the mounting bracket points away from the unit.

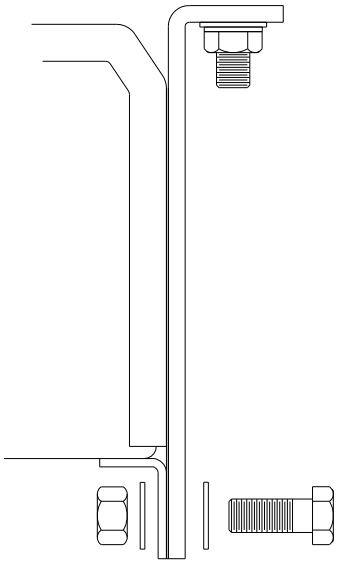


Figure 2-10: Bolt Mounting Bracket to Unit

2. Place one piece of Uni-Strut (open channel up) at each end of the CO unit, across the flanges of the mounting brackets, lining up the holes. For each **All-Thread stud**, run on a **½" nut** approximately 1" from the rod end. Slip on a **lock washer**, and thread the short end of the stud through the Uni-strut and mounting flange. Secure firmly in place with a **flat washer** and **nut**. The unit should now look as shown in Figure 2-11.

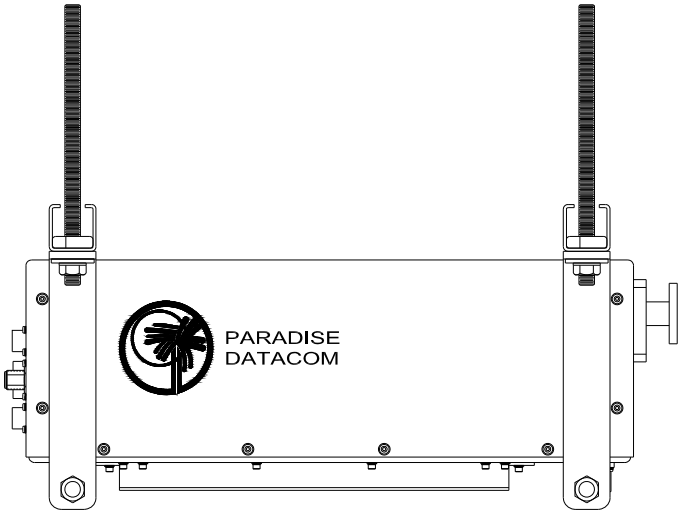


Figure 2-11: Unit Ready for Boom Installation

3. Bring the unit up tight under the boom (with the long axes parallel), sliding the All-Thread studs past the sides of the boom to show above the boom top. Place the remaining pieces of Uni-strut (open channel down) across the boom, onto the protruding All-Thread stud ends. Secure firmly with a flat washer and ½" nut on each of the four All-Thread stud ends. Looking from the end of the boom, the mounted unit should look as shown in Figure 2-12.

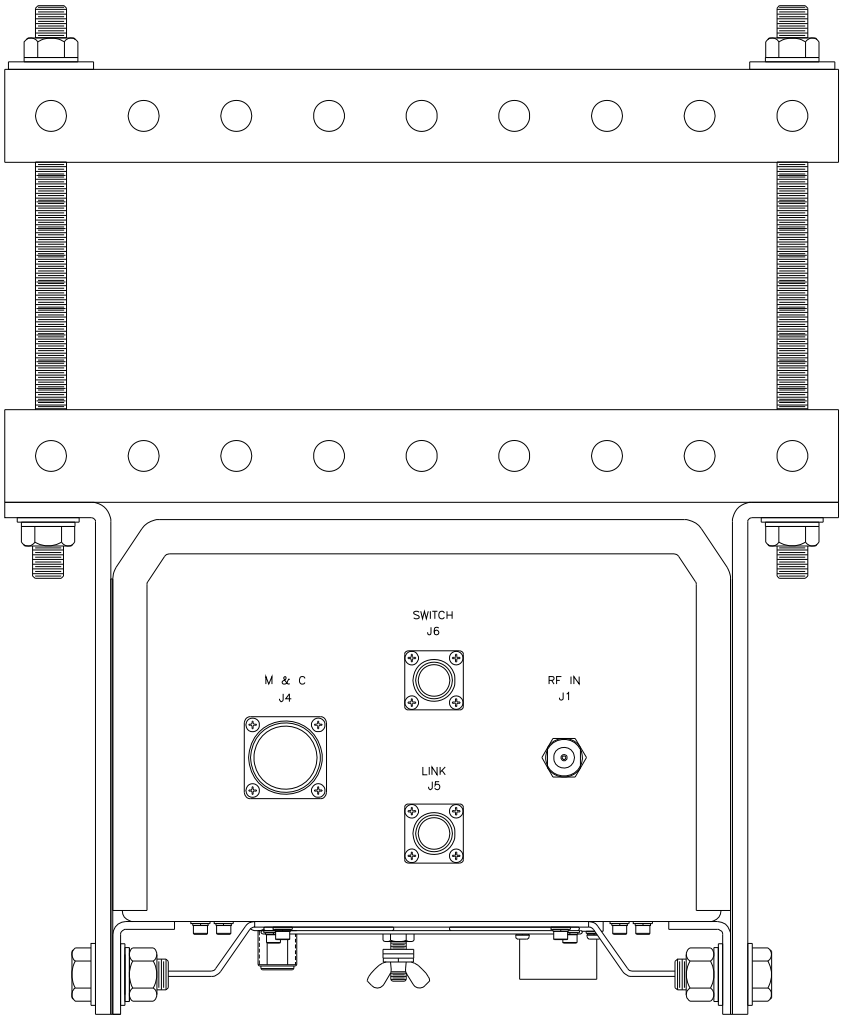


Figure 2-12: Compact Outdoor Mounting Completed

4. Connect the Compact Outdoor SSPA unit's power source, RF Input and RF Output as directed elsewhere in this manual.

DO NOT APPLY POWER TO THE COMPACT OUTDOOR UNIT BEFORE TERMINATING THE RF OUTPUT CONNECTOR.

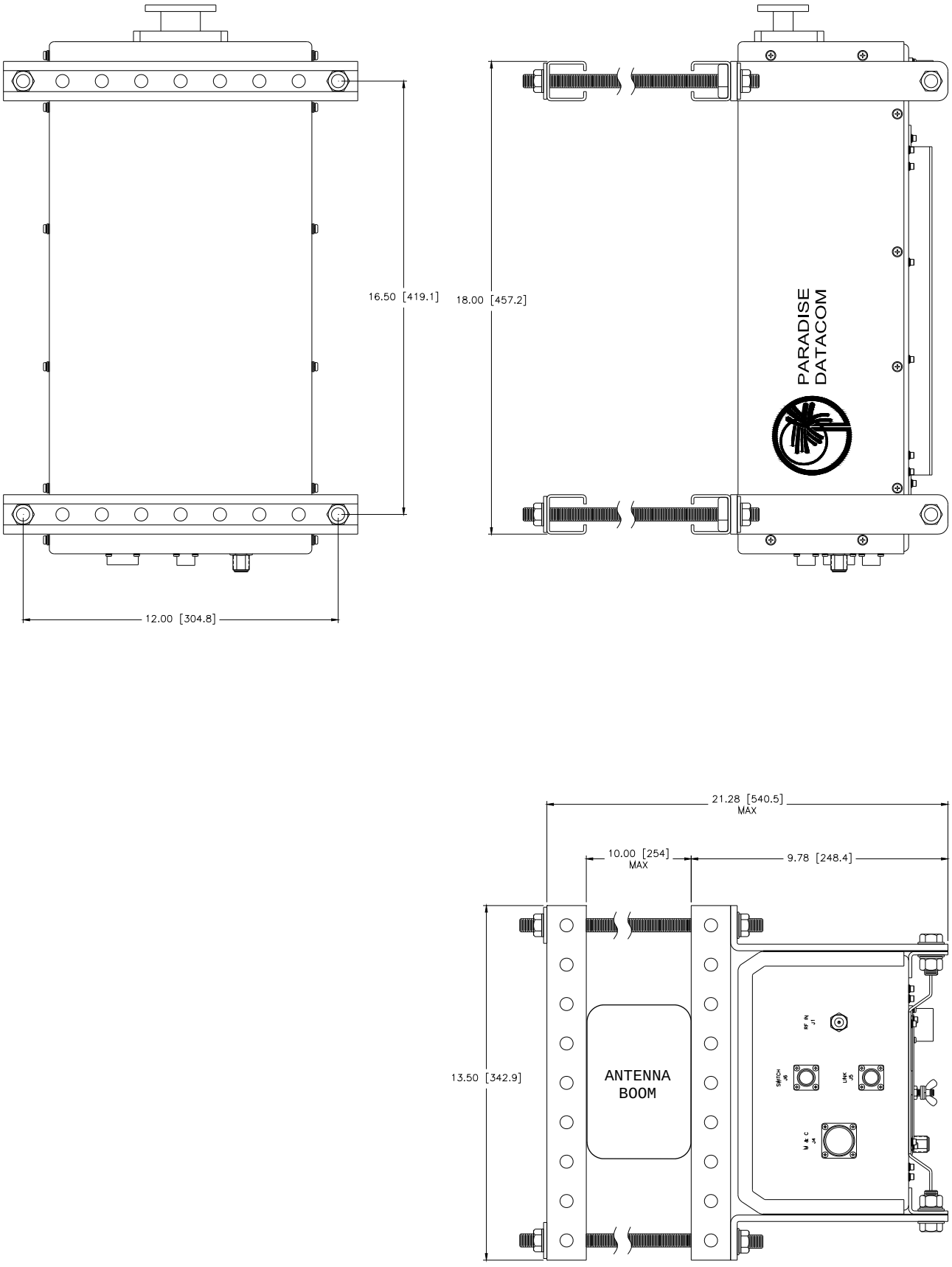


Figure 2-13: Outline Drawing, Compact Outdoor Mounting Kit

3.0 Introduction

This section of the manual describes the operation of the Compact Outdoor Solid State Power Amplifier. The Compact Outdoor unit has been designed for maximum flexibility in amplifier system configuration. It has a full compliment of parallel I/O monitor and control signals as well as serial I/O capability using a PC and host communication software from Paradise Datacom LLC. Table 3-1 shows the pin out of the Monitor and Control connector, J4.

3.1 RF Input (J1)

The RF Input signal is applied to J1. The Compact Outdoor SSPA has a default maximum nominal gain of 75 dB minimum. Therefore the maximum input signal required to saturate the amplifier can be calculated as:

$$\text{Input Power} = P_{sat} - 75\ \text{dB}$$

For example, if a 50 W Ku Band Compact Outdoor amplifier is used in a system it has a P_{sat} = 47.0 dBm. Therefore the maximum input power should be limited to -28 dBm. Slightly higher input power levels will not damage the amplifier but will result in higher levels of distortion in the output signal.

WARNING! The maximum input level should be limited to +15 dBm to avoid damaging the amplifier.

3.2 RF Output (J2)

The amplifier's output is taken from the waveguide port, J2. Caution should be observed here to make sure that the antenna or a suitable termination is connected to this port before operating the amplifier. The amplifier is protected against full reflection but dangerous levels of microwave energy can be present at this port.

WARNING! Never look directly into the RF output waveguide.

3.3 Amplifier Enable (Mute/Unmute) (J4)

The Compact Outdoor Amplifier has no on/off switch or circuit breaker in the AC Input path. As soon as AC power is applied to J7, the unit's power supplies and microcontroller are enabled. The operator will be able to observe the forced convection cooling fans running. However, the internal amplifier module is disabled until the Mute Line Input (J4 – Pin B) is pulled to Ground (J4 – Pin V).

If it is desired to have the RF enabled every time the AC input is applied, a permanent connection can be made from J4-Pin B and Pin V.

Table 3-1: Monitor & Control Connector, J4

Signal	Type	Function	Pin	Notes
Mute Input	Closure to Ground	Disables DC Power to SSPA	B	Unit Powers up Muted, This line must be pulled to ground (V or d) to enable amplifier
Auxiliary Input	Closure to Ground	Auxiliary Fault Input	P	
Summary Alarm	Form C Relay	Closed on Fault Common Open on Fault	L a b	L-a : normally open a-b : normally closed
Auxiliary Alarm	Form C Relay	Closed on Fault Common Open on Fault	N Z M	N-Z : normally open Z-M: normally closed
	Open Collector	High on Fault	W	Reserved
Auxiliary Alarm	Open Collector	High on Fault	G	Requires external pull-up
Voltage Alarm	Open Collector	High on Fault	H	Requires external pull-up
Current Alarm	Open Collector	High on Fault	J	Requires external pull-up
Temperature Alarm	Open Collector	High on Fault	X	Requires external pull-up
Spare Fault	Open Collector	High on Fault	S	Requires external pull-up
RF Power Detector	Analog Output	Relative Indication of RF Output Power	R	+4.0 vdc at Psat
Gain Adjust Input	Analog Input	Adjusts Amplifier Gain over 20dB range	A	2.5 vdc = Max Gain 75dB 0.5 vdc = Min Gain 55dB
Block Up Converter Alarm	Open Collector	High on Fault	f	Requires external pull-up
RS232 / RS485 Select	Closure to Ground	Selects Serial Communication	D	Default is RS 485; pull to ground (V) to enable RS 232
RS 485 TX- or RS232 OUT	Serial TX Output	Serial Link Data Port	E	
RS 485 RX- or RS232 IN	Serial RX Input	Serial Link Data Port	F	9600 default Baud Rate
RS 485 TX+	Serial TX Output	Serial Link Data Port	T	
RS 485 RX+	Serial RX Input	Serial Link Data Port	U	
GND	Signal Ground	Common Signal Return	V, d	
Baud Select 0	Closure to Gnd	Select Baud Rate & Protocol	j	Refer to Appendix C
Baud Select 1	Closure to Gnd	Select Baud Rate & Protocol	e	Refer to Appendix C
PGM Switch		Flash Firmware Port	g	Reserved for Programming
PGM CLK		Flash Firmware Port	c	Reserved for Programming
PGM-Sout		Flash Firmware Port	K	Reserved for Programming
PGM-Sin		Flash Firmware Port	Y	Reserved for Programming
PGM +5V		Flash Firmware Port	h	Reserved for Programming
PGM Enable		Flash Firmware Port	C	Reserved for Programming

3.4 Alarms (J4)

A variety of alarm signals are present at the M&C connector, J4. Both Form-C relays and open collector outputs are available. An amplifier summary alarm is available in both Form C relay and open collector output. Detailed internal faults are available in open collector form and include: voltage, current, and over-temperature.

3.4.1 Summary Alarm (J4) Form C Contacts

The Summary Alarm is accessible in both Form C relay and open collector format. The form C relay is “energized” under normal operating conditions and “deenergized” when a fault condition exists.

3.4.2 Auxiliary Alarm (J4) Form C Contacts

The Auxiliary Alarm relay is an end user alarm that can be used to signal an alarm condition that is dependent on the state of the Auxiliary Input (J4-Pin P).

The Auxiliary Input is a contact closure to ground. When this input is pulled to ground the Auxiliary Alarm relay is energized (Normal State). When the Auxiliary Input is open circuited the Auxiliary Alarm relay is de-energized (Alarm State).

One example usage of the Auxiliary Alarm is that it could be used to signal one of the detail alarms (voltage, current, or temperature) by connecting the appropriate open collector alarm output to the Auxiliary Input. This programs the Auxiliary Alarm relay to be either a voltage, current, or temperatue Form C relay alarm.

3.4.3 Open Collector Alarm Outputs (J4)

The open collector alarm outputs will require external pull-up resistors (unless connected to the Auxiliary Input). They are capable of sinking up to 20mA current at 30 VDC. The open collector outputs are pulled to ground under normal operating conditions and switch to high impedance state during an alarm condition.

Auxiliary Alarm: follows state of Auxiliary Input as described above
Voltage Alarm: high when amplifier’s internal regulator voltage falls below its acceptable level
Current Alarm: high when the amplifier’s operating current falls below its acceptable level
Temperature Alarm: high when the amplifier’s baseplate temperature rises above its acceptable threshold of 90°C. A 5°C hysteresis window exists in the temperature alarm.
Spare Alarm: high when the phase locked local oscillator’s lock alarm is triggered

3.5 RF Power Detector (J4)

The RF Power Detector is an analog output voltage that is proportional to the RF output power. The maximum output voltage is 4.0 VDC which corresponds to the maximum (saturated) output power from the amplifier. This detected voltage is useful over a 20 dB range of output power.

3.6 RF Output Sample (J3)

An RF sample of the amplifier's output is available at J3. This is a -40 dBc coupled sample of the amplifier's output signal.

3.7 Gain Adjust Input (J4)

The Gain Adjust Input allows an analog voltage that is applied between (J4 – Pin A) and Ground (J4 – Pin V) to control the gain of the amplifier. The gain is adjustable over a 20 dB range with 0.1 dB resolution. The applied voltage is directly proportional to amplifier gain.

2.5 VDC = Maximum Gain: 75 dB
0.5 VDC = Minimum Gain: 55 dB

The Compact Outdoor SSPA is factory default to have maximum gain with no analog gain adjust. The gain adjustment must be enabled by running the setup program from a host PC. This prohibits any accidental gain adjustments that may occur from unintentional analog voltages that may be present on the Gain Adjust Control J4-Pin A.

The gain is also adjustable using a host PC and the supplied Paradise Datacom Monitor and Control program. See the Serial I/O Section for details on Serial Control.

3.8 Serial I/O Control (J4)

For serial data control of the Compact Outdoor SSPA, a Windows-based Monitor &Control program is supplied with the amplifier that allows all of the control and alarm functionality over a serial communication link.

Both RS232 and RS485 can be used to communicate with the amplifier. The amplifier default is to operate on RS485 but can easily be set to RS232 by pulling the RS232/RS485 Select line low. This is done by connecting J4-Pin D to J4-Pin V.

Communication Links using RS232 are typically good up to 30 ft. (9 m) in length. Installations exceeding this length can use the RS485 mode which will allow serial control up to 4000 ft. (1200 m).

The Compact Outdoor Amplifier is supplied with a cable in which this connection is already made. This allows the user to quickly setup the amplifier and verify its operation. The other side of the cable has a 9-Pin female D connector that mates with most notebook and desktop personal computers.

3.9 Compact Outdoor Amplifier Quick Start Guide

- Unpack the amplifier and connect the RF Input and RF Output as described earlier in this manual.
- Connect the AC input power to connector J7.
- Connect the supplied “Quick-Start” Control Cable (201433) from port J4 to an available Comm Port on your computer. The cable schematic is shown in Appendix A.
- Install the Windows-based Paradise Datacom Universal Monitor and Control Program from the supplied CD.
- Run the Paradise Datacom Universal Monitor and Control Program from the Programs Menu of your PC.
- Select [Action] 7 [Add Unit] from the main menu of the Universal M&C Program and select [Compact Outdoor SSPA] from the menu choices. See Figure 3-1.

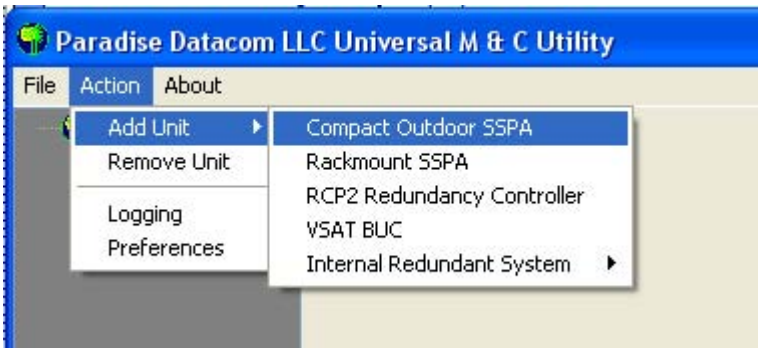
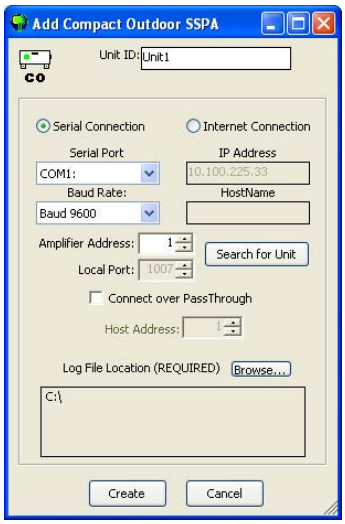
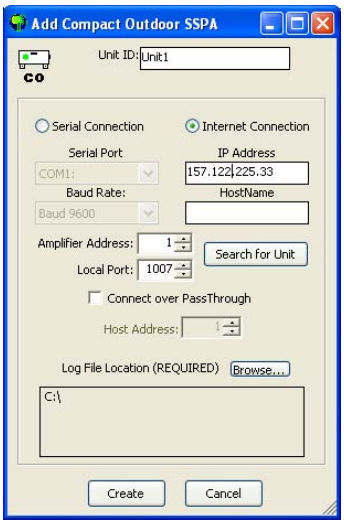


Figure 3-1: Universal M&C Add Unit menu

- A new dialog window will open (see Figure 3-2). Enter the following information where applicable: Unit ID, Serial Port for communication, Baud Rate. Only serial connections are available with a standalone Compact Outdoor SSPA. The addition of a Remote Control unit (RCP2-1000-CO) allows connection via Internet Protocol.

Serial connection ►





◄ Internet connection

Figure 3-2: Add Compact Outdoor SSPA window, via Serial (left) or Internet (right)

- Specify the unit's Address in the Amplifier Address box. If you don't know the address of the unit you may search for it. Be aware that this search feature is only useful when you have only one unit connected to your PC at a time.
- If you wish to change the log file location, click on the [Browse] button and navigate to the desired location. See Section 3.9.3 for more information about the log file.
- Click on the [Create] button to generate the operation window for this unit.
- The M&C "Operation" window will be displayed as in Figure 3-3, and includes tabs for the unit Status window, Settings and IP Setup (where applicable).

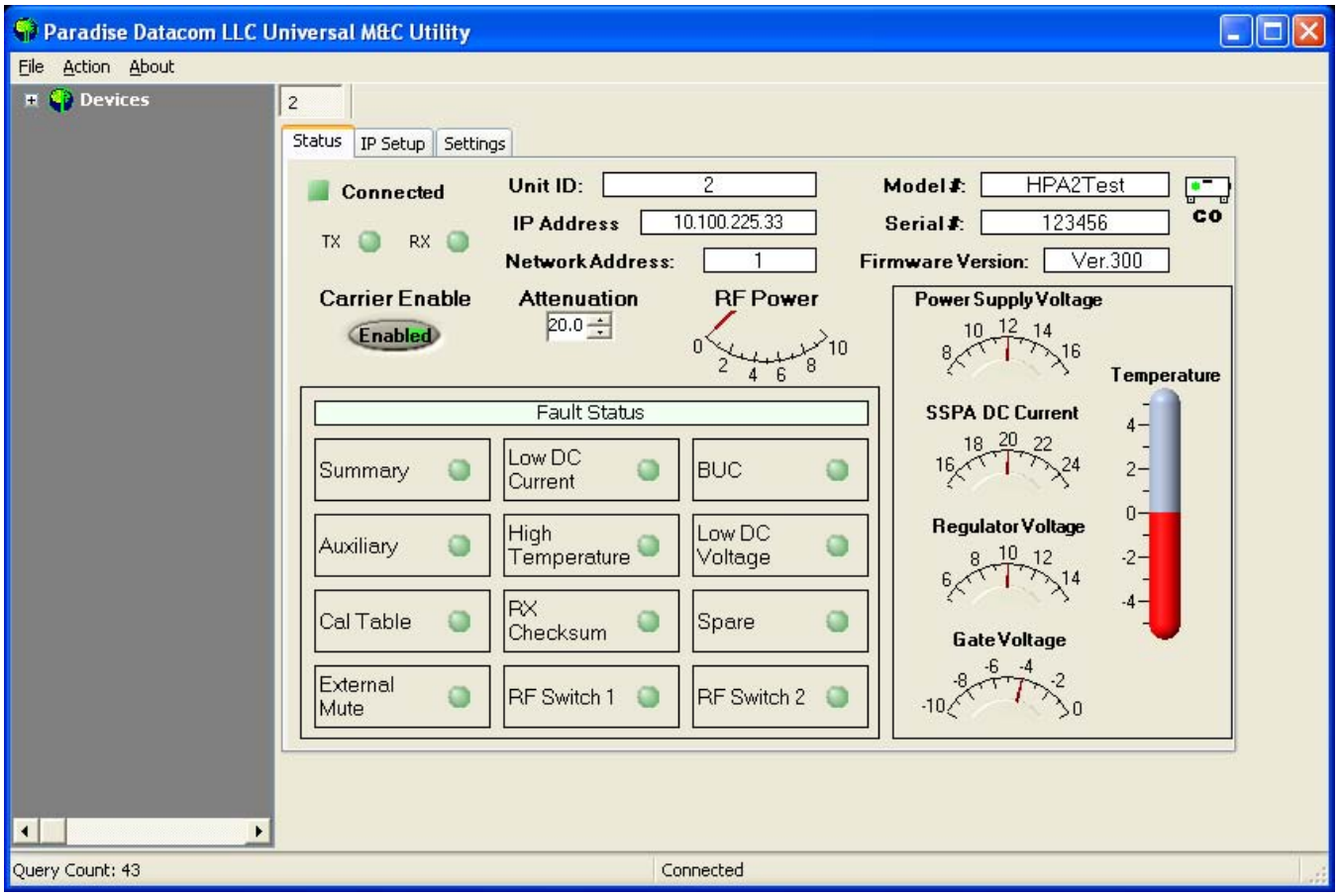


Figure 3-3: Universal M&C Status Window

3.9.1 Status Window

The Status Window is the main monitoring display, and shows the the current conditions (or state) of the Compact Outdoor SSPA. In addition, the status screen allows for Mute/Unmute of the carrier and manual adjustment of the on-board Attenuator for gain control.

Upon connection with a unit, the M&C application obtains and displays the unit ID, the amplifier's model number and serial number. The SSPA module's firmware version number is also displayed here for convenience.

The unit's network address and serial COM or IP address are also listed, which can be helpful in optimizing serial communications.

3.9.1.1 Signal Indicators

Three rows of LEDs show the connection status of the connected amplifier. Top-most is an indicator that displays a green LED when Connected, or a red LED when Disconnected. Immediately below are two LEDs for the TX and RX paths. The LED in the third row displays the mute state (Carrier Enable). This is actually a toggle which allows the user to Enable or Mute the amplifier.

3.9.1.2 Fault Status Indicators

The Fault Status frame in the lower left side of the Status Window contains 12 SSPA fault lights that correspond to :

Summary Alarm	Low DC Current (SSPA Module current)	BUC (Optional Block Up Converter fault)
Auxiliary	High Temperature (SSPA Module Baseplate)	Low DC Voltage (SSPA internal voltage regulator)
Calibration Table	RX Checksum	Spare
External Mute	RF Switch 1	RF Switch 2

Summary Alarm: The Summary Alarm is simply a logical 'OR' of any of the alarm indicators.

Low DC Current Alarm: The Current Fault is factory preset to alarm if the SSPA module current falls below 80% of its nominal value.

BUC Alarm: The BUC fault is only active in units that are supplied with an optional L-Band Block Up Converter module. If the Up Converter's phase locked local oscillator loses lock, a BUC alarm is set and the amplifier is muted so that spurious RF can not be transmitted to the satellite.

Auxiliary & Spare Alarms: The Auxiliary and Spare Alarms are configurable from the Settings Window. See Section 3.9.2.

High Temperature Alarm: The Temperature Fault indicator is factory preset to alarm at 80° C. The amplifier will continue to operate up to 90°C. Beyond 90°C the DC power will be interrupted to the SSPA module. This measure will protect the sensitive microwave transistors from catastrophic failure. The fans and monitor and control circuitry will continue to operate normally. This function has approximately a 5°C hysteresis window which will allow the amplifier to re-enable itself when the ambient temperature is reduced by 5°C. The Temperature Alarm is intended to warn the operator of possible fan problems and eventual amplifier shutdown.

Low DC Voltage Alarm: The Voltage Alarm is factory preset to alarm if the SSPA module current falls below 80% of its nominal value.

Calibration Table: The Cal Table Alarm is used under initial test at the factory.

RX Checksum Alarm: The RX Checksum Alarm indicates when an invalid checksum byte is communicated to the unit.

External Mute Alarm: The External (Ext) Mute line gives an indication via the M&C screen that the SSPA has been externally muted by J4-Pin B. This external mute alarm can be configured to trigger a summary alarm if desired. The factory default is to signal a External Mute fault but no Summary Alarm.

RF Switch Alarms: The RF Switch 1 Alarm is only active if a 1:1 Redundant System has been configured in the M&C program. The RF Switch 2 Alarm is only active is a 1:2 Redundant System has been configured. These configuration are covered in Section 7, the Redundant System Concepts description.

All of the above alarms, with the exception of the RF Switch and External Mute Alarms, are available as open collector outputs and Form C relays on the J4 parallel interface.

3.9.1.3 Voltage, Current and Temperature Display

On the right side of the Status window there is a thermometer display that reports the present baseplate temperature of the amplifier. The baseplate temperature typically experiences a 20 to 30 degree rise above ambient on the highest power Compact Outdoor Amplifiers and 15 to 20 degree rise on lower power units.

To the left of the thermometer display are several indicators that show various operating conditions of the Compact Outdoor Amplifier in real time. These indicators are helpful for any diagnostic proceedures. Among the horizontal indicators include:

- Power Supply Voltage
- SSPA DC Current
- Regulator Voltage
- Gate Voltage

The Power Supply voltage monitors the primary 12 volt power supply output. SSPA Current is the total current drawn by the microwave transistors. Regulator Voltage is the DC voltage of the drain circuitry that feeds the GaAs transistors. The Gate Voltage indicator monitors the DC voltage of the gate circuitry of the microwave GaAs transistors. These indicators provide direct access to the active device operating characteristics.

3.9.1.4 Gain Adjustment

The Gain Attenuation Control is located above the Fault Condition Indicators and to the right of the Carrier Enable status. The gain can be adjusted by setting the Attenuation Control. An Attenuation Control of 0 dB is the maximum gain (75 dB) setting on the amplifier. By setting the Attenuation Control to 20 dB; the gain is set to (55 dB). The Attenuation Control can be varied using the control knob or the forward/reverse buttons.

Note the illuminated PC Control button inside the Attenuation Control frame. This control allows the gain adjustment function to be assigned to the analog input voltage (J4-Pin A). The gain adjustment control must be either under PC control or analog voltage control; **it cannot be both**.

3.9.1.5 RF Power Indicator

The RF Power indicator is the vertical meter in the central part of the Operation window. This indicator reports the approximate output power of the amplifier. It uses the voltage from the RF Power Detector to determine a corresponding power level in dBm. The accuracy of the power indicator is ± 1 dB at the mid-point of the specified band, with a single CW or QPSK carrier.

3.9.1.6 Carrier Enable

This button toggles between the “Enabled” and “Muted” conditions. This software mute requires 70 msec maximum (30 msec typical) to take effect.

3.9.2 Settings Window

Figure 3-4 shows the ‘Settings’ window of the Paradise Datacom Universal Monitor & Control Software. The ‘Settings’ window contains many of the global settings that are available in the SSPA.

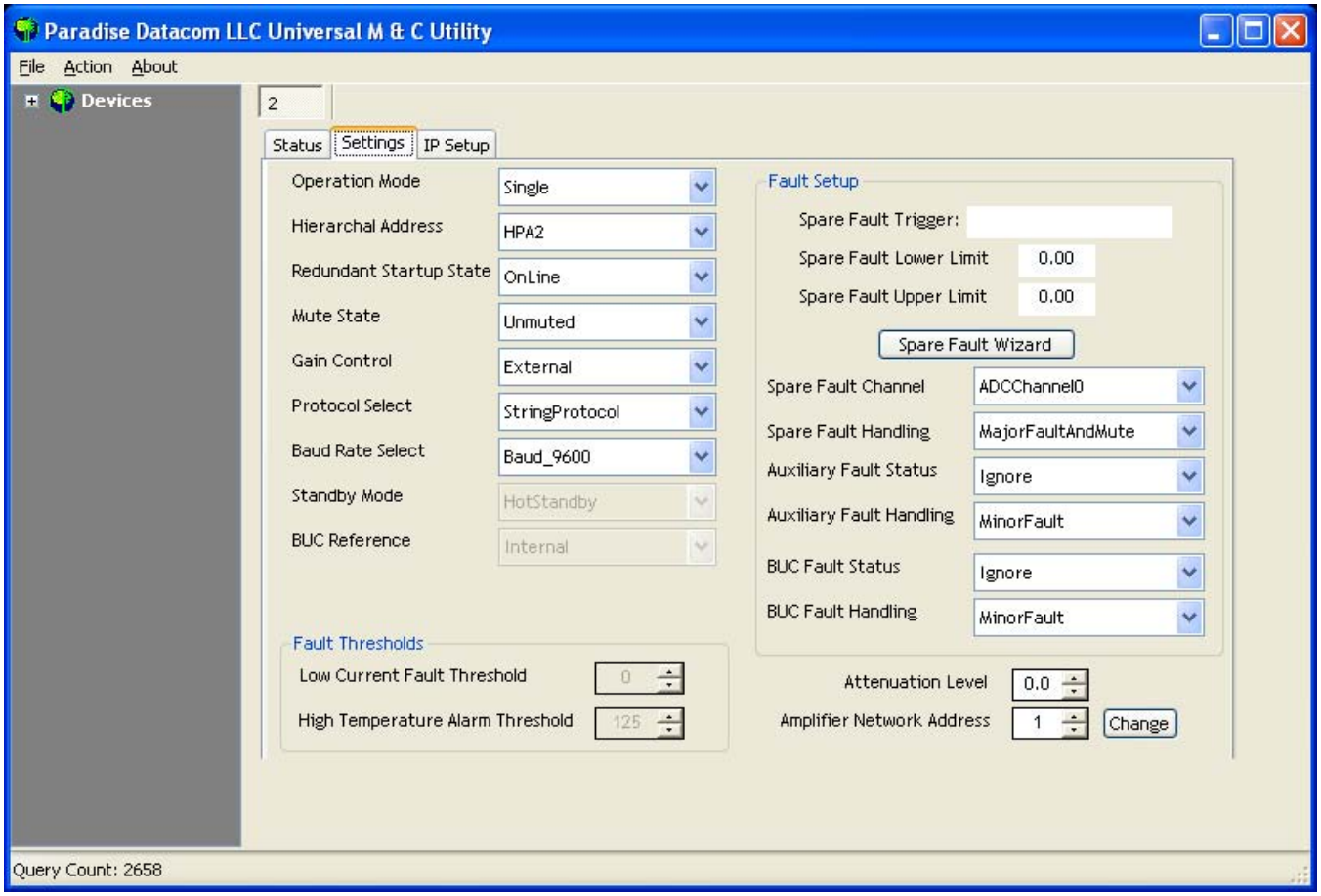


Figure 3-4: Universal M&C Settings Window

3.9.2.1 Power Up Settings

The Compact Outdoor amplifier will power up with the “last-state” settings before the unit was powered down. Whatever attenuation setting or mute state the amplifier was in when powered down will be the restored settings when the amplifier is powered back on.

Operation Mode: Select between stand alone (single unit) or redundancy mode of operation.

Hierarchical Address: Identifies each amplifier in a redundant system as HPA 1 or HPA 2.

Redundant Startup State: Selects whether the unit should start up as the on-line amplifier or the standby amplifier.

Mute State: Determines if the unit should start up muted (transmit disabled) or mute clear (transmit enabled).

Gain Control: Select between serial communication control of the unit’s gain or analog voltage gain control via J4.

Protocol Select: Selects between the standard string protocol of Section 9 or older generation binary based protocol.

Baud Rate: Sets the baud rate of the unit. The supported baud rates include: 2400, 4800, 9600, 19200, and 38400 baud. The factory default baud rate is 9600.

Standby Mode: Selects between Hot and Cold standby mode for units in redundant systems.

BUC Reference: Selects between an Internal or External reference for an optional block up coverter integrated with the unit, or allows the unit to Auto-switch between Internal and External reference.

Fault Thresholds: Allows the user to set the limit for triggering the unit’s Current Fault or High Temperature Fault.

Low Current Fault Threshold: Range is 0 to 102.3, with each 0.1 equal to 97.75 mA.

High Temperature Alarm Threshold: Range is 0 to 125 °C.

Fault Setup: This feature allows the user to set the Spare Fault Trigger using the Spare Fault Wizard.

Click on the Spare Fault Wizard button, which opens a new window. See Figure 3-5. Select between the following fault triggers: LNB Current, Gate Voltage, Regulator Voltage, Power Supply Voltage, SSPA Current, External Mute, or None. Set the range of maximum and minimum thresholds that would trigger the selected fault, and configure the fault handling via a pull-down menu. Click [OK] to set the fault trigger for the Spare Fault.

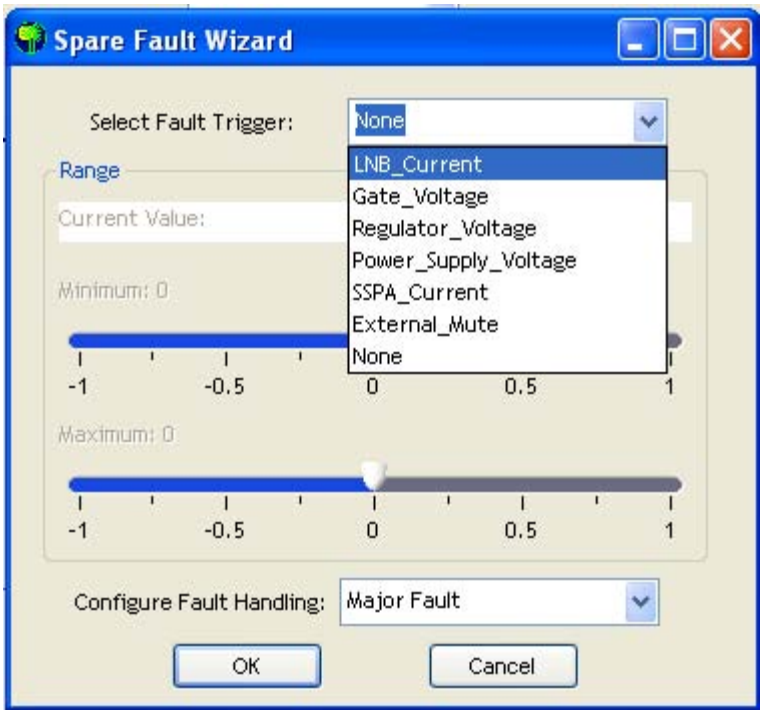


Figure 3-5: Spare Fault Wizard

The user may also adjust the Spare, Auxiliary and BUC Fault Status and Handling via the appropriate pull-down menus on the Settings Window.

> **Spare/Auxiliary/BUC Fault Handling:** Selects whether the associated fault should be a major or minor fault, and whether the fault should mute the unit. A minor fault will trigger a Spare/Auxiliary/BUC Fault alarm but not trigger a Summary Fault. A major fault will trigger both an Spare/ Auxiliary/BUC Fault and a Summary Fault.
>
> **Auxiliary/BUC Fault Status:** Determines if the associated fault input should be ignored or enabled (either Logic High or Logic Low; or Logic Z-State for Auxiliary Fault).

Attenuation Level: The Gain Adjustment of the unit is adjustable here. See Section 3.9.1.4.

Unique Network Address: Sets a network address for the unit. Range is 0 to 255.

3.9.3 Universal M&C Preferences

The user can adjust certain preferences of the Universal Monitor and Control Software. See Figure 3-6.

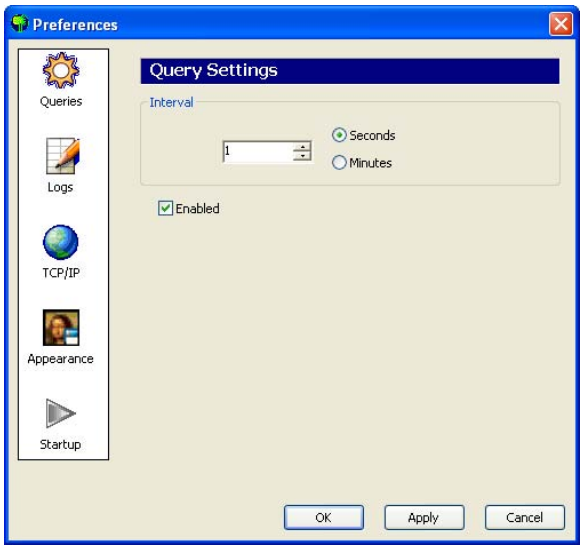


Figure 3-6: Preferences Window

Queries: Enable and adjust the interval that the software queries the unit. Note that if queries are disabled, there will be no communication with the unit at startup.
Logs: Enable and adjust the interval that the software writes to the log. The log location is determined during unit setup, with the default location set to the My Documents folder. Each entry catalogs the RF Power Level and Temperature of the unit. See Figure 3-7 for an example of a log entry.

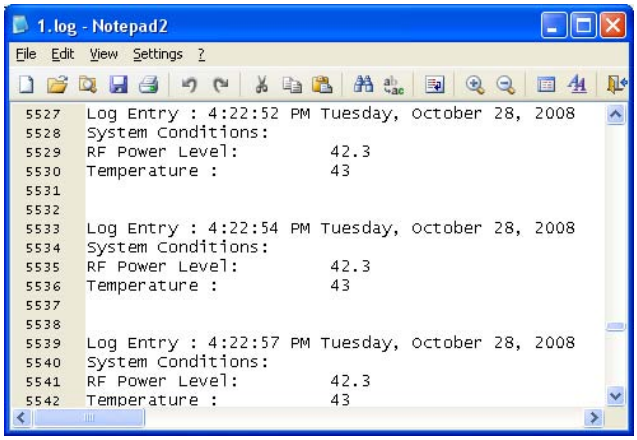

1.log - Notepad2
File Edit View Settings ?
5527 Log Entry : 4:22:52 PM Tuesday, October 28, 2008
5528 System Conditions:
5529 RF Power Level: 42.3
5530 Temperature : 43
5531
5532
5533 Log Entry : 4:22:54 PM Tuesday, October 28, 2008
5534 System Conditions:
5535 RF Power Level: 42.3
5536 Temperature : 43
5537
5538
5539 Log Entry : 4:22:57 PM Tuesday, October 28, 2008
5540 System Conditions:
5541 RF Power Level: 42.3
5542 Temperature : 43

Figure 3-7: Example, Log entry

TCP/IP: Select the Local UDP Port (the software must be restarted to take effect). Note that each UDP address must be unique.
Appearance: Set the transparency of the M&C Windows.
Startup: Enable or disable auto-loading of the last device configuration.

4.0 Introduction

This section contains information on the theory of operation of the Compact Outdoor Solid State Power Amplifier. This includes a discussion of the system block diagram, amplifier module operation, and unique cooling system.

The Compact Outdoor Solid State Amplifier has been designed to be an extremely robust microwave amplifier system. It is very well suited for environmentally demanding conditions where reliability is paramount. At the heart of the amplifier system is a multifunction solid state power amplifier (SSPA) module.

Proprietary thermal management techniques allow even the highest output power level amplifiers to operate reliably in environments up to 60°C ambient temperature and 100% relative humidity.

Figure 4-1 shows the block diagram of the amplifier system. As seen in the block diagram there are five major active components:

1. EMI Filter and Transient Protection
2. Power Supply
3. Solid State Power Amplifier Module
4. Fan Boost Converter
5. Cooling System

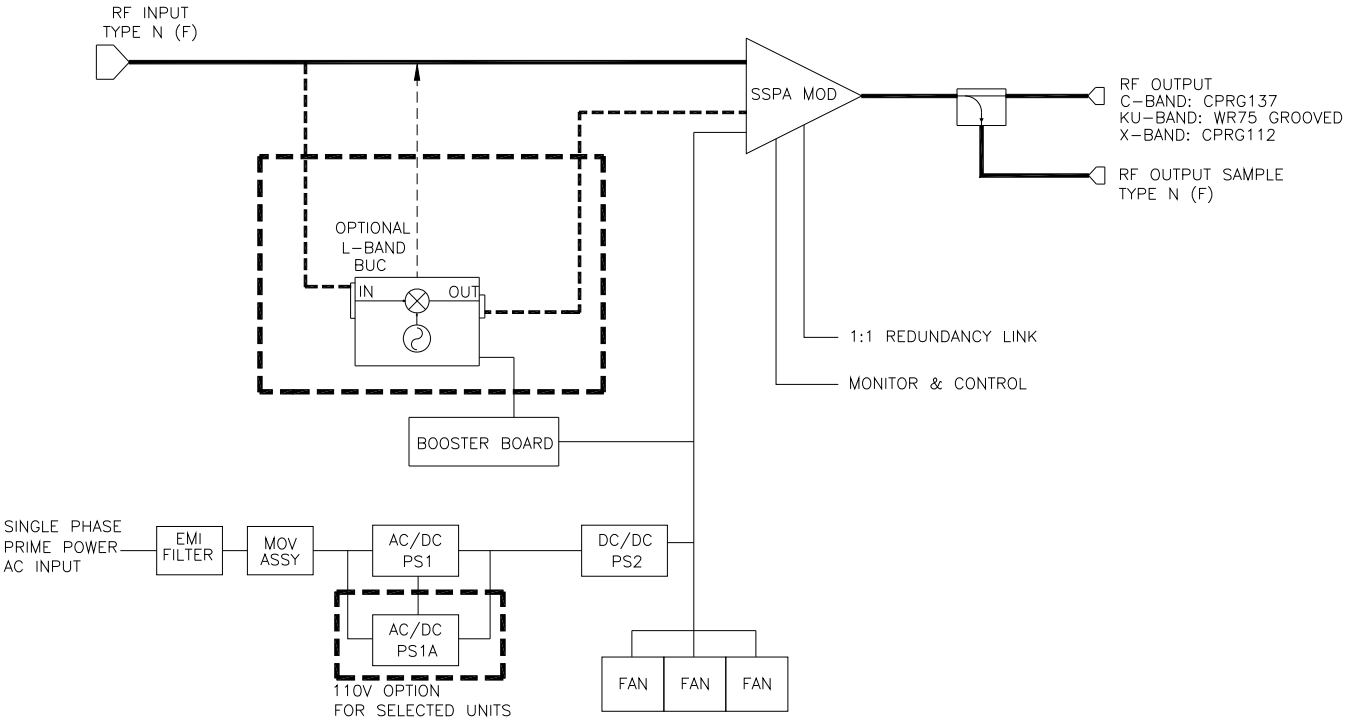


Figure 4-1: Block Diagram, Compact Outdoor Amplifier

4.1 EMI Filter and Transient Protection

The EMI (Electro-magnetic Interference) Filter is a passive electronic device used to suppress conducted interference present on any power or signal line. It may be used to suppress the interference generated by the device itself as well as to suppress the interference generated by other equipment to improve the immunity of a device to the EMI signals present within its electromagnetic environment. The filter was designed with an added Metal Oxide Variable resistor (MOV) to provide transient voltage and surge protection.

4.2 Power Supply

The Power Supply consists of one or two AC/DC Converters and a DC/DC Converter.

4.2.1 AC / DC Converter

The prime AC input power is delivered to a switching converter module that produces 300 VDC. Depending on the input power requirement of the amplifier, there may be one or two AC/DC Converters present in the unit. These modules are auto-sensing, power factor corrected front ends that have proven reliability and allow the amplifier system to operate over a wide variety of input power conditions encountered around the world. A high current, common mode filter is used on the input side of the converter module that reduces switching components to very minimal levels.

4.2.2 DC / DC Converter

The DC/DC converter module is also a switched mode power supply that converts the 300 VDC to 12 VDC. This 12 VDC is the primary high current, DC voltage source that operates the entire amplifier system.

4.3 Solid State Power Amplifier Module

The amplifier module is a unique high density, multifunction module. It not only contains all of the RF signal amplification and distribution, but also is home to the microcontroller based monitor and control circuitry. An extremely robust regulation and bias control board supplies the power to the microwave GaAs FET devices. A separate microcontroller board provides the M&C functions for the amplifier. Some of the features of this board include:

(3) Serial Ports
- (1) Dedicated Flash Firmware Programming
- (1) Ethernet Port for Host Communication
- (1) Selectable RS232 / RS485 for Host Communication

(2) Form C Relays
- Summary Alarm, Auxiliary Alarm

(5) Open Collector Outputs
- Summary, Auxiliary, Voltage, Current, Temperature, Block Up Converter Faults

(2) Closure to Ground Inputs
- Mute, Auxiliary Input

(8) 10 bit Analog Voltage Measurement Channels

SSPA Module Current
Regulator Voltage
Power Supply Voltage
Negative 5v Gate Voltage
Optional Power Supply Temperature
RF Output Power Detector
Analog Gain Adjustment

(1) 10 bit D/A for SSPA Gain Adjustment / Temperature Compensation
20 dB gain adjustment with 0.1 dB resolution

(1) Very Accurate Digital Temperature Sensor
0.5 degree resolution within 1°C of SSPA module case temperature

4.4 Fan Boost Converter

The Fan Boost Converter is a separate DC/DC boost converter that produces a 24 VDC source from the 12 VDC output of the main power supply. This voltage source is then used to power the cooling system fans.

4.5 Cooling System

The Compact Outdoor Amplifier's cooling system represents a landmark in microwave telecommunication amplifiers. It is a unique system of heatsinks that have been computer optimized to provide extremely efficient cooling of all of the system's functional blocks. This high efficiency cooling system is primarily responsible for the small overall package size and reduced weight of the unit (as low as 36 lbs or 16.4 kg).

The cooling system is based on a forced convection technique in which the system fans provide the air intake while the exhaust is brought out around the outer perimeter of the fans. The fans are 103 CFM rated and operate into approximately 0.7 in. H_2O back pressure.

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5.0 Introduction

This section describes some of the standard RF tests performed on production amplifiers before shipment. Where possible Paradise Datacom, LLC maintains computer automated RF test stations to ensure a high level of accuracy and consistency to production amplifier testing.

5.1 Gain and Gain Flatness

The amplifier gain is swept over the operating frequency range under small signal conditions to confirm the minimum gain and gain flatness specifications. The entire Compact Outdoor Amplifier is tested in a temperature chamber from -40°C to +55°C; and the gain is recorded.

5.2 P_{1dB}

The 1 dB Gain Compression Point is measured at discrete frequencies across the band to characterize the output power over the operating frequency range. The P_{1dB} is a guaranteed minimum specification.

5.3 Input and Output Return Loss

The input and output return loss are measured in all production amplifiers. This is a measure of how closely the amplifier is matched to its characteristic impedance. The input impedance of the amplifier is a nominal 50 ohms while the output is matched to the waveguide complex impedance.

5.4 Spurious

Spurious signals are undesirable byproducts of amplifiers caused by nonlinearities within the amplifier and other system level components such as switch mode power supplies. These unwanted signals cause signal management problems in system applications. Out of band spurious signals cause interference to other pieces of equipment.

5.5 RF Sample Port

The RF Sample port is measured at discrete frequencies across the band and a calibration label is placed near the type N connector on the bottom of the unit. The sample port is approximately -40 dB down from the RF output. A label with the exact coupling ratio is attached to the amplifier chassis.

5.6 Intermodulation Distortion

Intermodulation distortion is one of the most important characteristics of a solid state power amplifier system. Satellite communication systems must comply to certain distortion levels depending on the service involved. All production amplifiers are subjected to automated intermod testing. This is based on a standard two-tone intermod test in which the intermod level (IMD) is measured in dBc with respect the main tones and the highest third order intermod products.

Satcom amplifiers are typically used in some 'back-off' condition. This is the operating point at which the composite output power is 'backed-off' from the amplifier's P_{1dB}, compression point. A curve of back-off vs. IMD level is especially useful in the selection of a power amplifier or determining the proper output power setting in a Satcom system.

Paradise Datacom recognizes the importance of this back-off characteristic and provides a plot of back-off Vs IMD from 1 dB to 10 dB back from the amplifier's compression point. Figure 5-1 shows a typical back-off curve from a production test set.

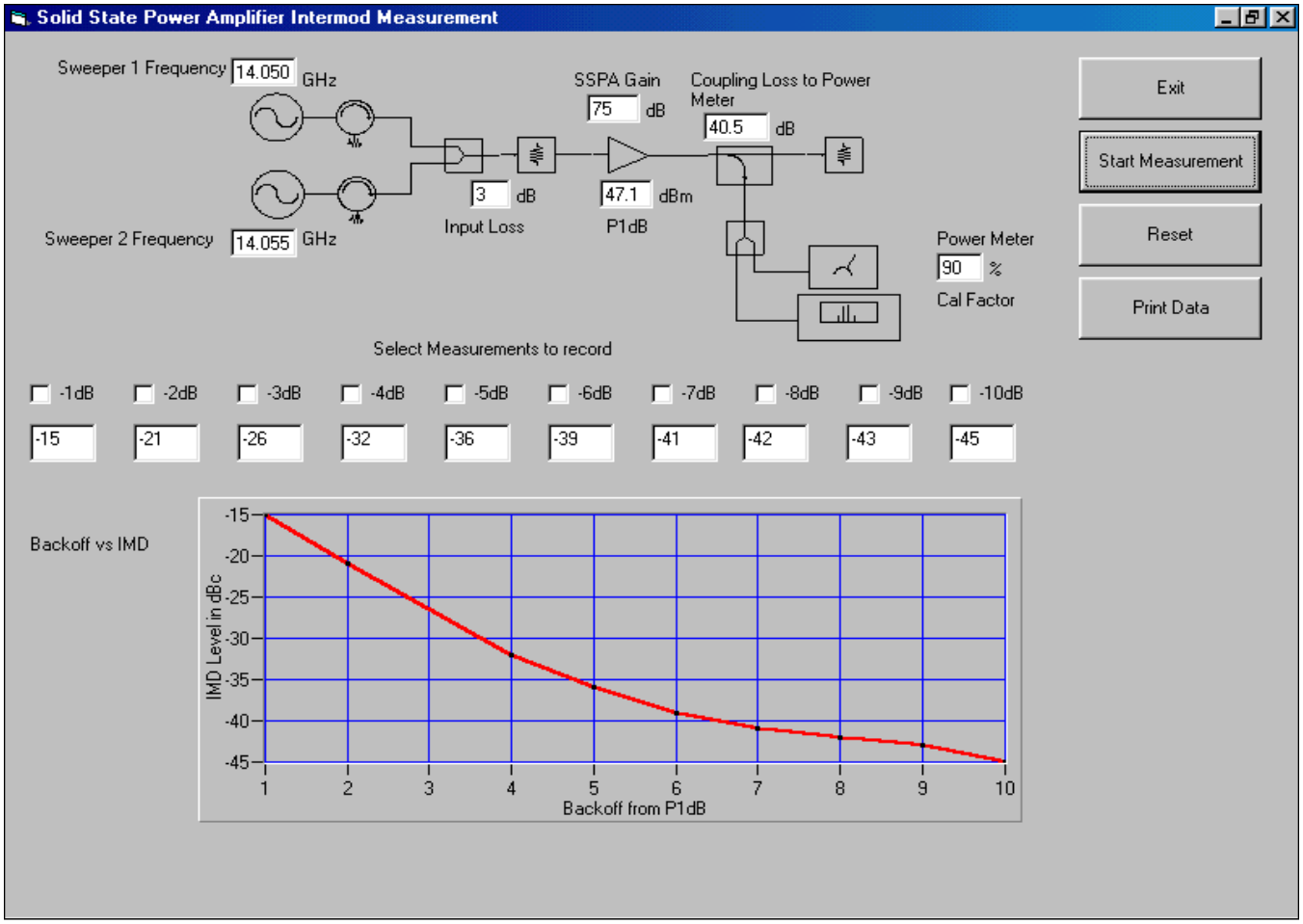

Figure 5-1: IMD vs. Backoff for a 50W Ku Band Compact Outdoor SSPA

6.0 Introduction

This section describes some of the standard maintenance practices that can be performed on the Compact Outdoor Amplifier.

6.1 Cooling System Maintenance

It is recommended that the cooling system be checked at least once per month. This involves visually inspecting the fan intakes to make sure that there is no obstructions over the intake. The Windows-based M&C program can be used to check the amplifier base plate temperature. The base plate temperature should normally not exceed a 30°C to 35°C rise above the current outside ambient temperature. If the base plate temperature exceeds this temperature rise, it is one indicator that the system's airflow requires maintenance.

The heat sink fins in the exhaust path can be visually inspected for excessive dirt and debris buildup. If it appears there is excessive debris in the heat sink; the fan tray can be removed for easy cleaning. **Failure to keep the fans and heat sink clear of debris will void your warranty.**

6.2 Fan Removal

It is recommended to remove prime AC power from the amplifier when the fan tray is being removed. However, if necessary, the fan tray can be removed while the amplifier is operating. Caution should be used to make sure that no clothing or fingers are caught in the fan blades. Simply remove the four screws from the fan tray and the fan assembly can be removed from the bottom of the amplifier assembly.

The fans are connected to their power source by weatherized in-line circular connectors. A replacement fan with connector can be provided for replacement. While the fan tray is removed, the heat sink fins can be cleaned by spraying compressed air throughout the finned area. A can of dust remover spray such as that which is found at a computer or electronics shop will work fine.

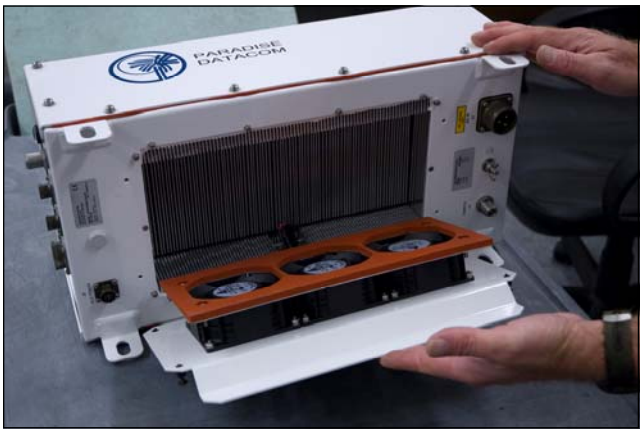

Figure 6-1: Fan Removal from Amplifier Assembly

6.2.1 Fan Replacement

Older models of the Compact Outdoor SSPA were fitted with a 2-fan cooling fan assembly. The newer models utilize a 3-fan cooling fan assembly.

While the fan interface connectors for the two-fan and three-fan tray assemblies are identical, they should not be used interchangeably.

If your Compact Outdoor SSPA was shipped from the factory with the three-fan air intake tray, any maintenance requiring replacement of the fans should only use the three fan kit (L205192 -1). The three fan kit requires 12VDC directly from the buss bar and draws 5.9A (70W).

If your Compact Outdoor SSPA was shipped from the factory with the two-fan air intake tray, any maintenance requiring replacement of the fans should only use fan kit L201814-1. This kit replaces one fan on the fan tray assembly. The two fan kit requires 28VDC from the booster circuit card assembly and draws 0.7A (19W).

Note: Failure to use the proper fan tray will cause damage to your amplifier!

It is possible to modify an older Compact Outdoor SSPA to be fitted with a 3-fan cooling fan assembly in place of a 2-fan assembly. This should be done by an authorized Paradise Datacom technician, using the procedure outlined in drawing number 206573.

6.3 Connector Weatherproofing

As a precaution against water intrusion, all cable connections should be wrapped with weather-resistant electrical tape, provided with the unit. Make sure each connector is clean and dry before applying the electrical tape.

Apply the electrical tape to all MS connectors and N-type connectors . Starting at the cable end, wrap the weather-resistant electrical tape around the connector, overlapping each turn by half the width of the tape. Continue wrapping until the connection mating point is enveloped. Wrap an extra turn around the base of the connector. Press and smooth the tape with your fingers to form a good seal. The tape surface should be uniform in appearance with no visible gaps or protrusions. See Figure 6-2.

Figure 6-2: MS connector, wrapped with weather-resistant self-sealing tape

7.0 Redundant System Concepts

The Compact Outdoor Amplifier is capable of operating in a variety of redundant system configurations. These include 1:1 and 1:2 as well as 1:1 with L-Band Block Up Converters. The Compact Outdoor Amplifier has a built-in 1:1 redundancy controller, allowing it to be used in 1:1 redundant systems without a separate external controller. When used in a 1:2 redundant system a separate controller, RCP2-1200, is required. The three most common forms of 1:1 redundant system are shown in Figures 7-1 through 7-3.

Figure 7-1 shows a standard 1:1 system in which the RF input is transmitted through a transfer switch along with the output. Using this configuration the standby amplifier carries no traffic and simply is terminated by a 50 ohm resistive load at its input and by a waveguide termination at its output.

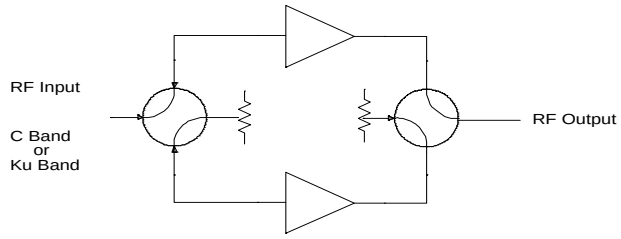

Figure 7-1: Standard 1:1 Redundant System with input (coaxial) switch and output (waveguide) switch

With the system configured as in Figure 7-2, the RF input is passed through a microwave splitter. This keeps 'live' traffic on the standby amplifier and is useful for observing the traffic via the RF sample port on the standby amplifier.

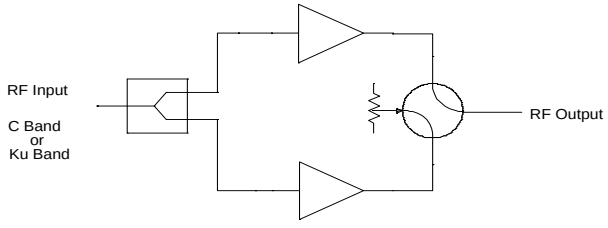

Figure 7-2: 1:1 Redundant System with input splitter substituted for input switch

The system shown in Figure 7-3 uses the same concept of the power splitter on the RF input. In this case the Compact Outdoor amplifiers are equipped with L-Band block up converters. L-Band input amplifiers use phase locked oscillators as the local oscillator to the up converter. Such systems must use a splitter at the input instead of a switch so that the reference input is always available to the standby amplifier. If the reference signal is lost the standby amplifier would report a BUC (Block Up Converter) fault.

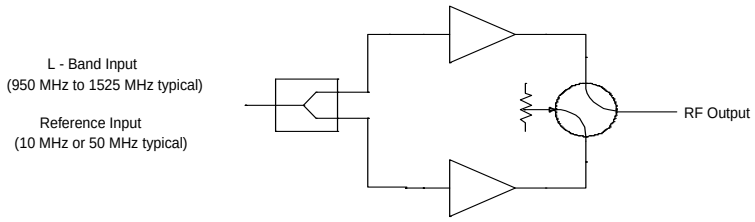

Figure 7-3: 1:1 Redundant System with L Band input

Care must be taken when selecting the splitter for an L-Band input system. The splitter must be a wide band design capable of passing the 10 MHz or 50 MHz reference signal along with the 950 MHz to 1525 MHz traffic input. The reference frequency power level must be at least –10 dBm into each Compact Outdoor Amplifier.

Figure 7-4 shows a typical antenna-mount application of a 1:1 Redundant Compact Outdoor SSPA system.

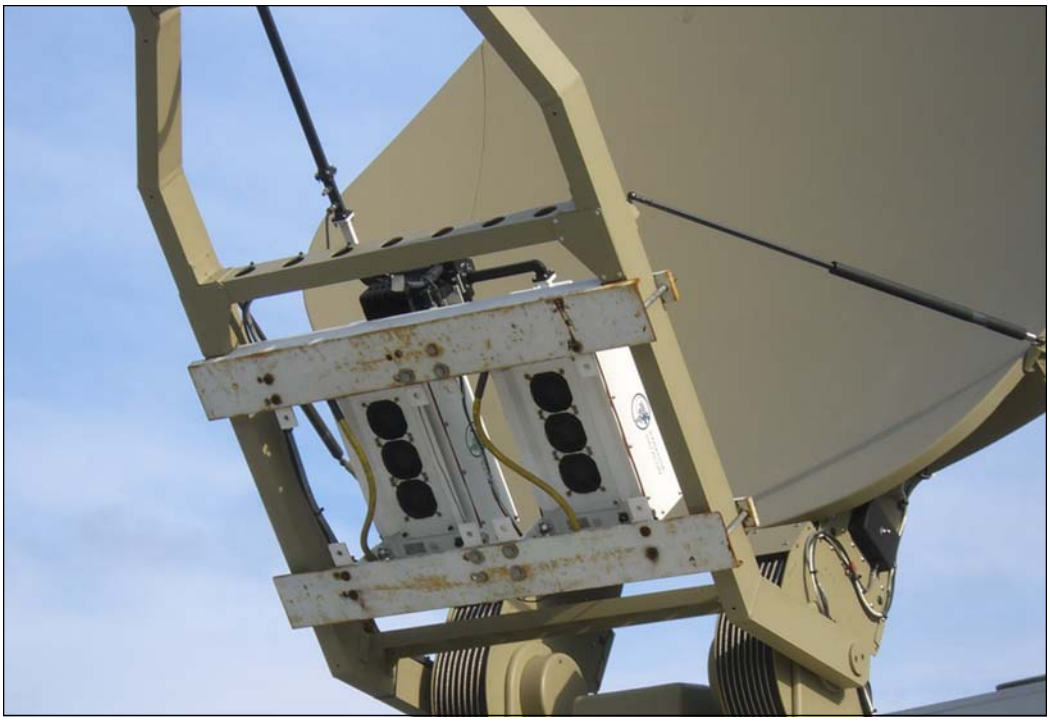

Figure 7-4: Antenna-mounted 1:1 Redundant Compact Outdoor SSPA System

7.1 Compact Outdoor Amplifier in 1:1 Redundancy

The Compact Outdoor Amplifier is ideally suited for a self-contained and cost effective 1:1 redundant system. Each Compact Outdoor Amplifier has a built-in 1:1 redundant controller. The controller is activated via computer command from the Paradise Datacom Universal M&C application. The Compact Outdoor Amplifier may be purchased as a redundant system or upgraded in the field from a single thread amplifier to a 1:1 redundant system.

A redundancy kit may be purchased separately which includes the following components:

- Mounting Frame
- Waveguide Switch / Mounting Bracket
- Input Splitter
- Waveguide bends from amplifier to switch
- High Power Waveguide Termination
- Coaxial cables from splitter to Amplifier input
- Link Cable
- Switch Cable
- Waveguide Flange / Extension for RF Output

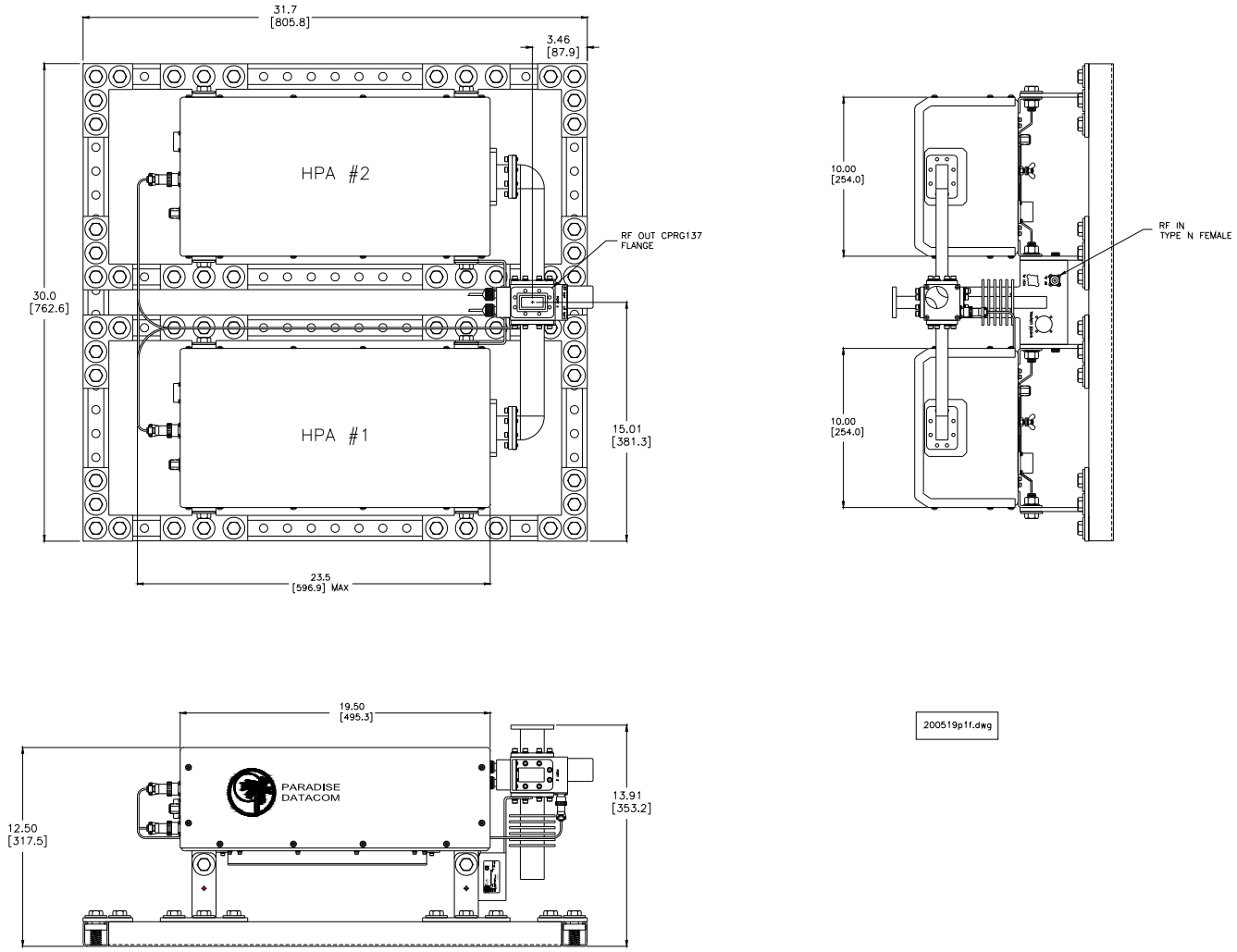

Figure 7-5: Typical 1:1 Redundant System Outline

7.1.1 Hardware Setup

The hardware setup for a Compact Outdoor 1:1 Redundant System is very simple and involves the addition of (2) cables along with a redundancy switch. A schematic diagram of the redundancy setup is shown in Figure 7-6.

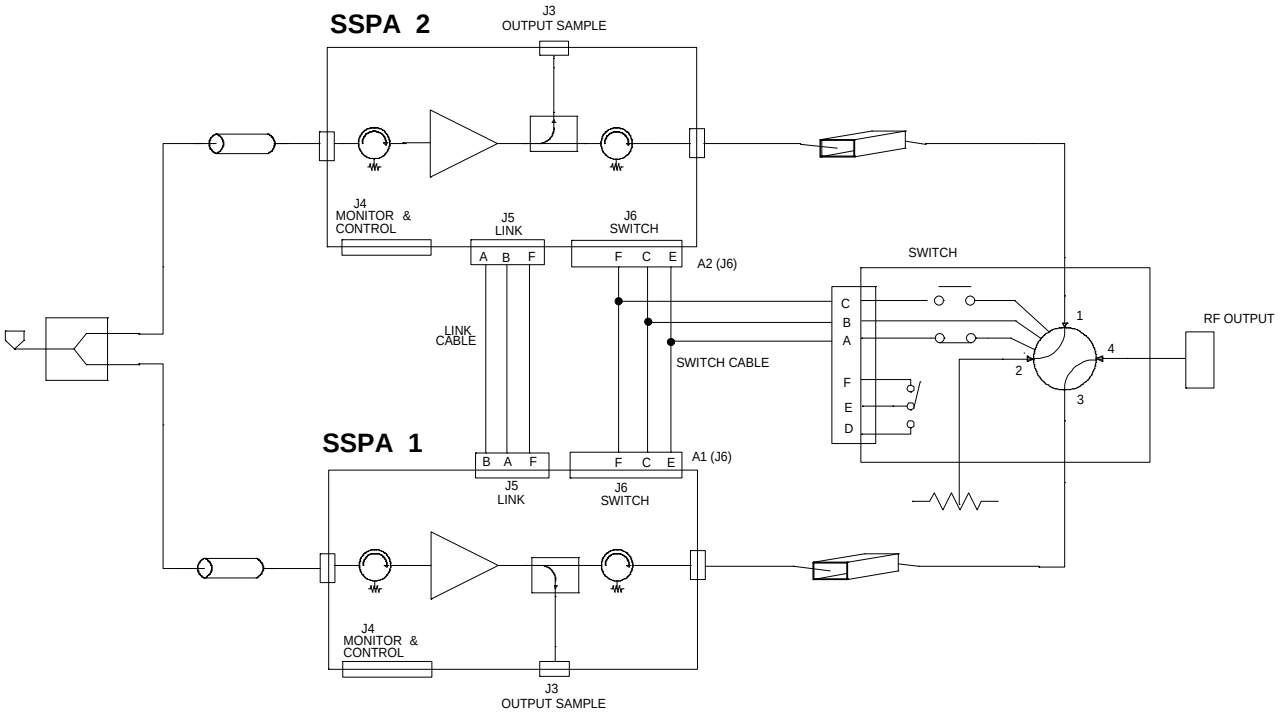

Figure 7-6: 1:1 Redundant System with Link Cable and Switch Cable installed

The Link Cable is a simple (3) conductor crossover cable that allows the system to pass command and control between amplifiers. With the redundancy kit, this cable is supplied in a 26 inch (660mm) length.

The Switch Cable is a “Tee” configuration and connects between each amplifier and the redundancy switch. The Redundancy Switch is a –28 VDC type. Therefore the controller in each Compact Outdoor Amplifier is capable of supplying +28 VDC to the common voltage input. Either controller may then provide a (sink) return to engage either position 1 or position 2 of the redundancy switch.

Care must be observed when connecting this cable to the amplifiers. The cable end labeled “A1” must be connected to the amplifier whose output is connected to Port 3 of the waveguide switch. Likewise the cable end labeled “A2” must be connected to the amplifier whose output is connected to Port 1 of the waveguide switch. This is for proper identification purposes of the Redundancy Control Firmware used by each Compact Outdoor Amplifier.

7.1.2 Software Setup

To instruct the Compact Outdoor Amplifier to operate in redundancy it is necessary to temporarily connect it to a PC running the Paradise Datacom Monitor and Control Software to set up the redundant configuration. There are 3 basic modes of Redundant System communication.

1. Stand-Alone 1:1 Redundant System—No Computer Control
2. PC Control using RS232 and Paradise M&C Software
3. PC Control using RS485 and Paradise M&C Software

7.1.2.1 Stand-Alone 1:1 Redundant System

As method 1 implies it is possible to have a 1:1 system operate with no PC monitor and control. Initially, however, it is necessary to connect each amplifier up to a PC to configure it for redundant operation. Figure 7-7 shows the redundant system with each amplifier enabled to use RS232 communication to a PC. Every Compact Outdoor amplifier is shipped from the factory with a “Quick Start” cable that can be used for this purpose. If the Compact Outdoor Amplifiers are purchased as a 1:1 Redundant System, this Software Setup procedure will have been set at the factory and it is not necessary to repeat this process.

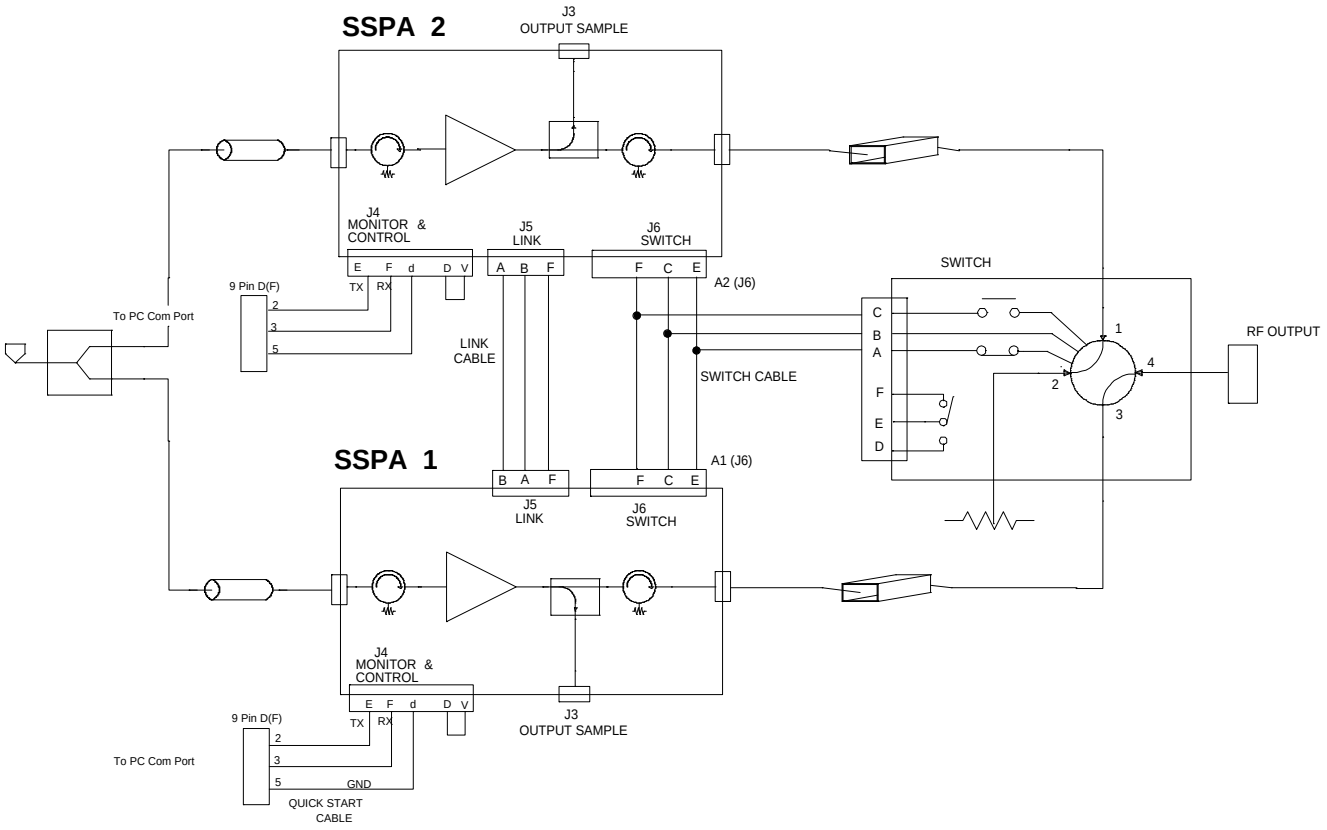

Figure 7-7: 1:1 System with RS232 Communication to each Amplifier

Each amplifier can be configured for redundancy by the Paradise Datacom Universal M&C software that ships along with each unit. Using the Quick-Start cable, connect each amplifier to the PC and run the M&C program. Select the "Settings" tab from the main form. The "Settings" window will appear as shown in Figure 7-8.

1. System Mode: Each SSPA's System Mode must be set to "1:1 Redundant Mode"

2. Choose a Hierarchical Address for each amplifier. HPA 1 means this SSPA will use the RF switch position 1 as its On Line state position. HPA 2 will then use RF switch position 2.

3. Redundancy Startup State: The amplifier which is desired to be on line should be set "On Line". The other amplifier should be set as "Standby".

All settings are valid as soon as the operator sets them on the SSPA Settings window. The SSPA's redundant operation can be verified by monitoring the RF Switch Fault indicator as shown in Figure 7-15.

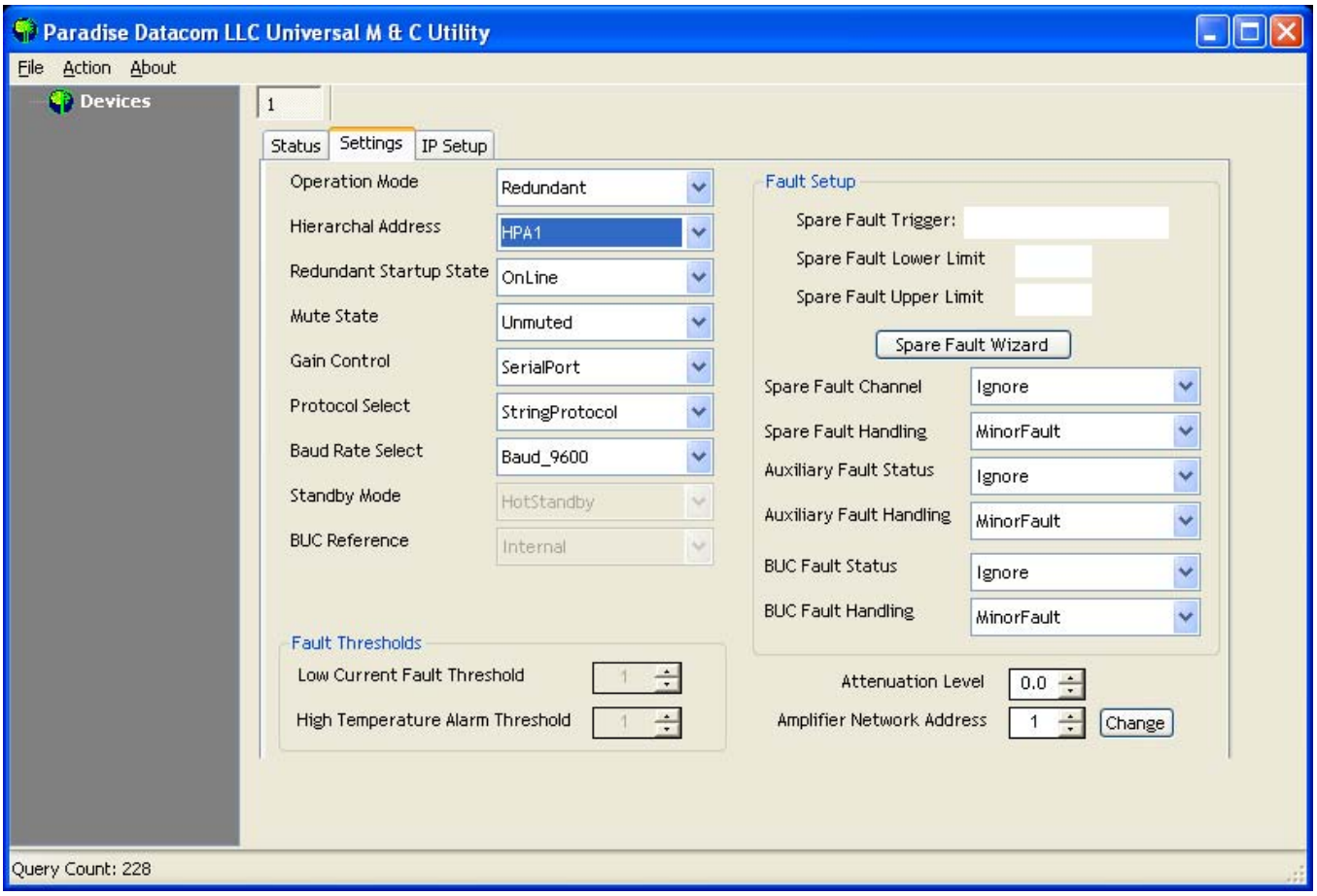

Figure 7-8: M&C Program "SSPA Settings" window

The Standby amplifier can be muted to have a “Cold Standby” condition. It keeps the SSPA module powered down for power savings while the microprocessor and fans remain operational. SSPAs with Parallel I/O board firmware version 3.50 or beyond are provided with a true cold standby mode. In this mode, the SSPA will be muted automatically. Cold standby mode has to be selected through a serial control interface (For details, see Table 10-6, data address 20).

If the Standby amplifier switches to the On Line state, it will automatically un-mute and transmit traffic. If the operator attempts to mute the On Line amplifier a warning message will be displayed “You are about to mute the On Line unit. Proceed with Mute?”

Similarly, connect the second amplifier to the computer’s COM port and perform the 1:1 selections on the SSPA Settings window. Just as with the first amplifier, make sure that the System mode is set to 1:1 redundant. Select a hierarchical address, HPA 1 or HPA 2 and a startup state.

The amplifiers may then be disconnected from the computer’s COM port as the Compact Outdoor Amplifiers’ microcontroller is now programmed for 1:1 redundancy control. It is not necessary to run the Windows based M&C software with the redundant system. The M&C software is only a convenience for remote monitoring and control of the redundant system. The following sections detail the operation of the M&C software in 1:1 redundant system operation.

7.1.2.2 PC Control using RS232 and Paradise Universal M&C Software

In applications requiring remote monitor and control of the redundant system, the Paradise Datacom Universal M&C program has a control panel that can be used for this purpose. To enable the 1:1 system to operate with the remote control software, first configure each amplifier for 1:1 redundant operation as previously described in the Stand-Alone 1:1 Redundant System section.

When using RS232, a separate COM port will be required for each amplifier. Therefore a computer with at least two COM ports is required for such a system. Systems using RS232 are limited by the length of the communication cable from the amplifiers to the computer. This is typically a maximum of 30 ft. (9 m) for most RS232 device drivers. Systems requiring longer communication cable links should use RS485 communication.

After starting the M&C program, select “Action” 7 “Add Unit” 7 “Compact Outdoor SSPA”. See Figure 7-9. The Add New SSPA window will appear as shown in Figure 7-10.

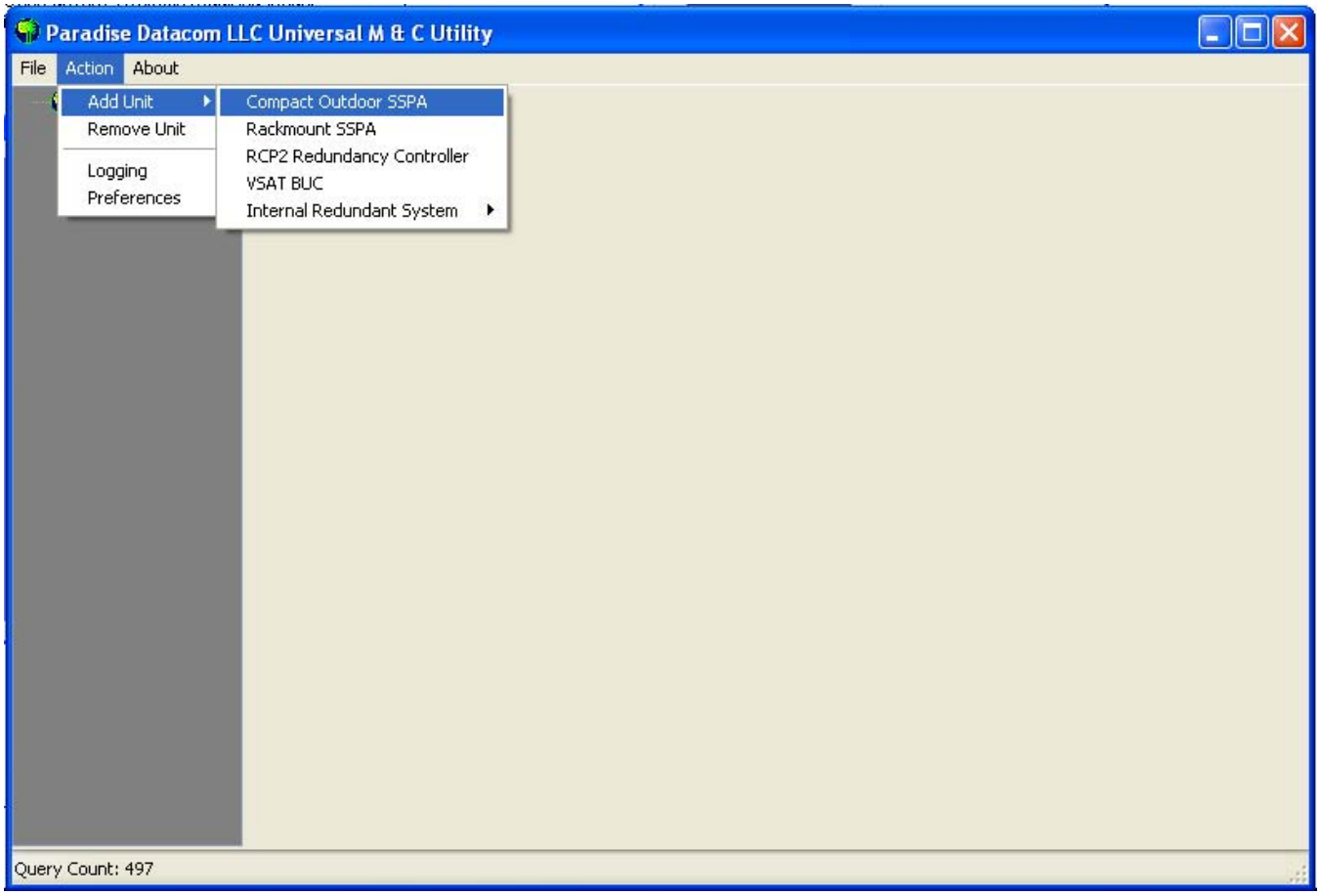

Figure 7-9: Adding a SSPA Monitor and Control Window

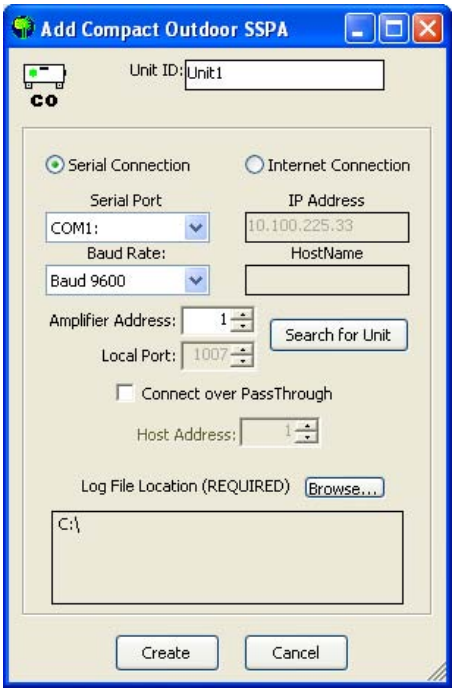

Figure 7-10: Add New Compact Outdoor SSPA window

From this screen choose the COM port and baud rate. The factory default baud rate is 9600. If a single SSPA is used the Global network address setting should be used.

After the COM port has been selected the "Operation" window will be displayed. At this point if the SSPA is connected to a power source and turned on, the SSPA will begin communicating with the M&C program and its operating parameters will be displayed.

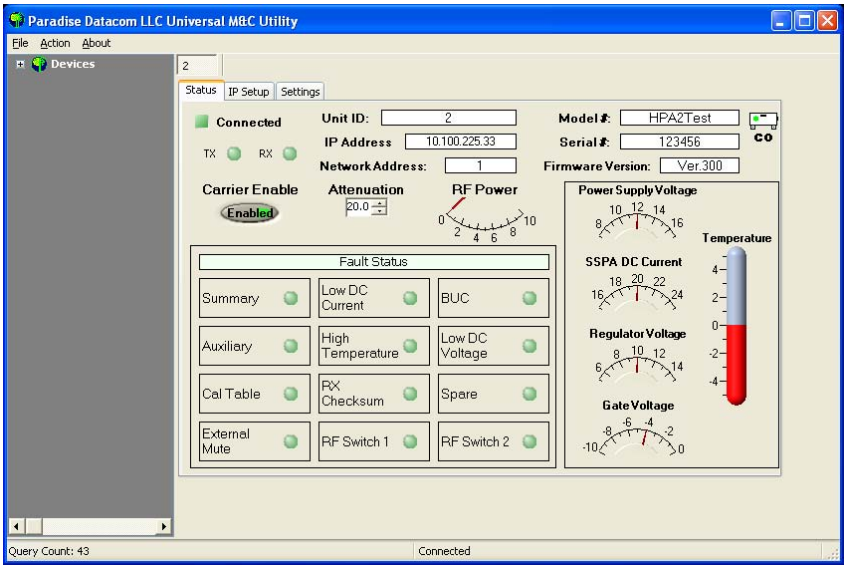

Figure 7-11: Individual SSPA Operation Window

Go back to the "Add New Local SSPA" window and select the correct COM port for the second amplifier. Its operation window will appear on the M&C program display. If either of the amplifiers is not communicating with the M&C Operation screen, debug the system to find the problem. Check the RS232 connection from each amplifier to the appropriate COM port of the PC.

Once reliable communication has been established between each amplifier and the computer, the Redundancy Control Panel can be displayed. From the M&C program's main window, choose "Action" 7 "Internal Redundant System" 7 "1:1 Compact Outdoor SSPA System". See Figure 7-12.

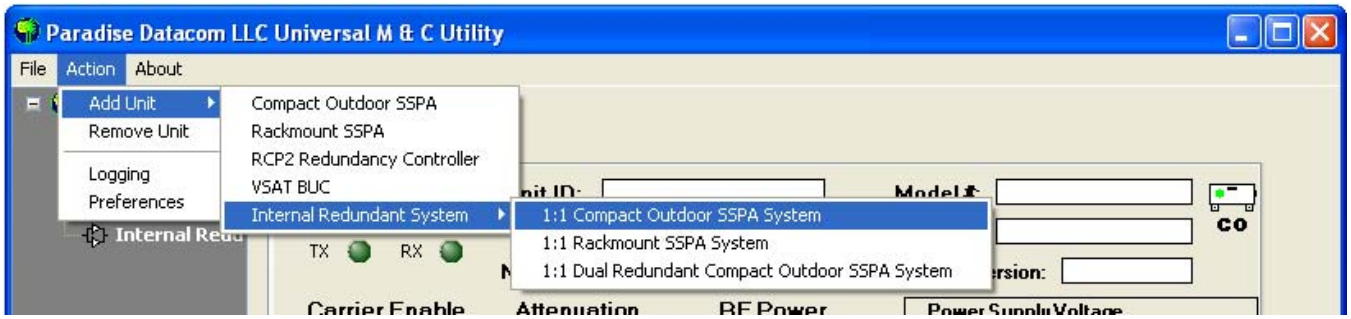

Figure 7-12: Paradise Datacom Universal M&C, Add Unit Menu Tree

The Redundant Control Panel window will then be displayed as in Figure 7-13. Note that once the Redundant Control Panel is enabled, the Main Menu on the M&C program changes.

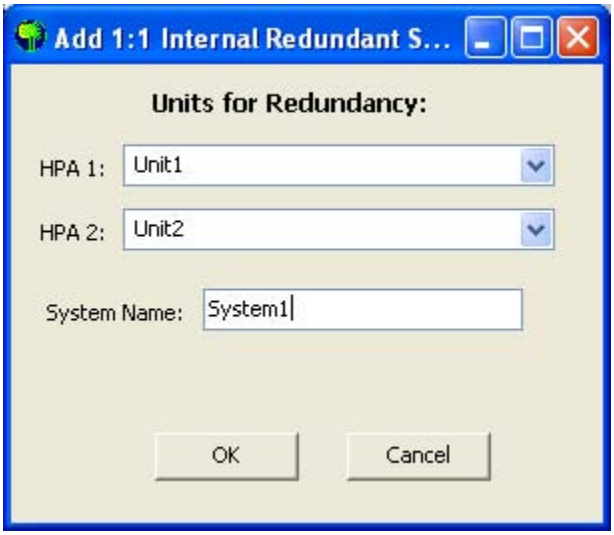

Figure 7-13: Add 1:1 Redundant System Window

The Control Panel must be configured by selecting "Set Redundancy System" and choosing an amplifier for SSPA 1 and SSPA 2. Either amplifier may be designated as SSPA 1 or SSPA 2. Each amplifier is identified by its ID number. The ID number is a fixed number and cannot be changed. It is a unique encoded value determined by the particular amplifier's model number and serial number. If the ID number is forgotten, refer to the System Watcher window. This window continuously displays which amplifier, by ID number, is connected to each specific COM port. After the Control Panel has been configured the display will change to the view shown in Figure 7-14.

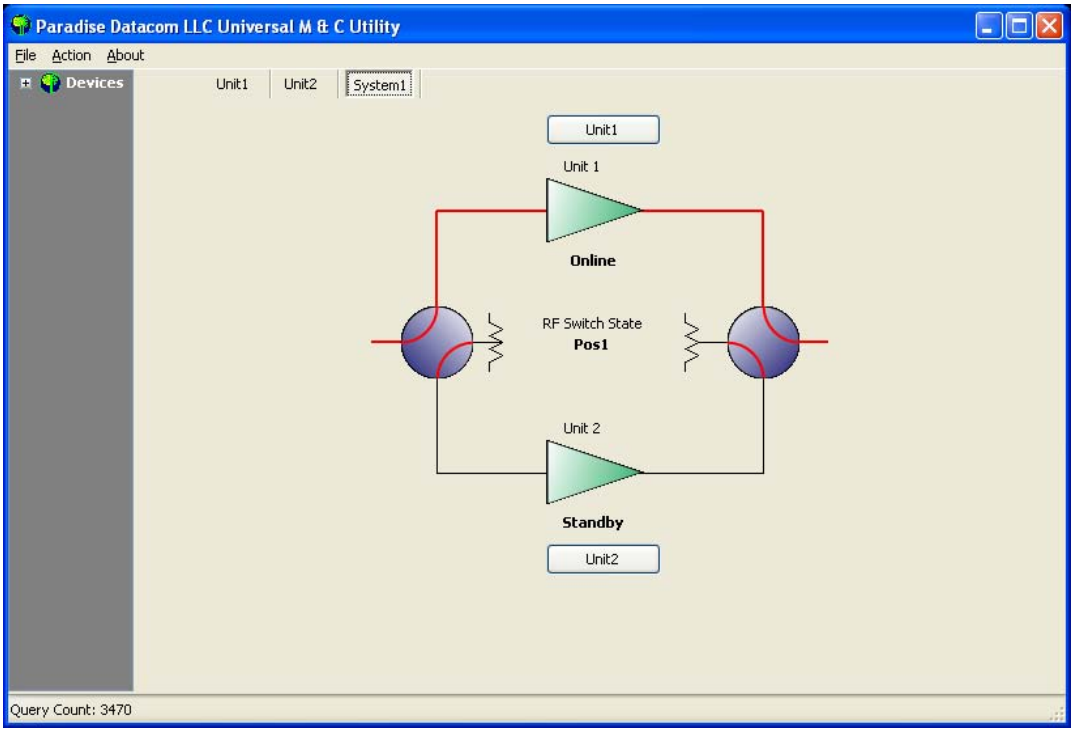

Figure 7-14: Redundant Control Panel in the Paradise Datacom M&C Program showing a configured 1:1 Redundant System

From the Control Panel display all typical 1:1 system functions can be monitored and controlled. A particular SSPA can be put on line be selecting the command button for either amplifier. The online amplifier will be indicated by the “Online” notation. The standby amplifier will be listed as such as shown in Figure 7-14 (Unit 2).

A particular redundant configuration can be saved by going to the “File” menu and selecting “Save Configuration”. Thus if the program is terminated and then restarted, it will immediately boot up with the Redundancy Control Panel display.

Each individual amplifier’s characteristics can still be monitored and controlled from its respective “Operation” window. If the user attempts to Mute an on-line amplifier, a warning window will pop-up asking if this is a valid request. See Figure 7-15.

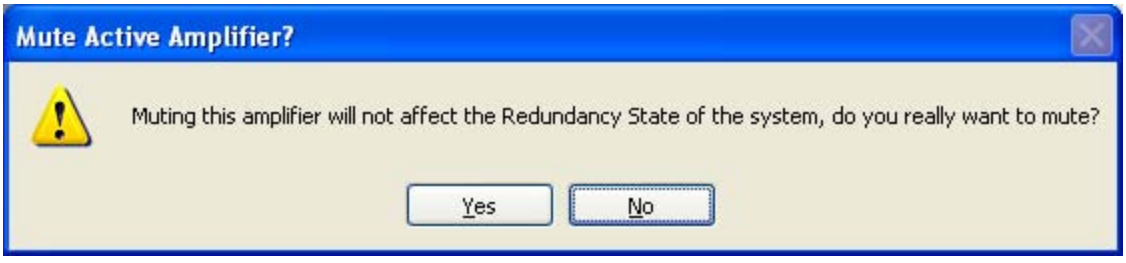
Mute Active Amplifier?
Muting this amplifier will not affect the Redundancy State of the system, do you really want to mute?
Yes
No

Figure 7-15: Dialog window, Affirm mute of on-line amplifier

If the online amplifier enters a fault condition, the redundant switch will automatically route the signal to the Standby amplifier. The faulted amplifier will be colored red in the Redundancy Control Panel display. See Figure 7-16.

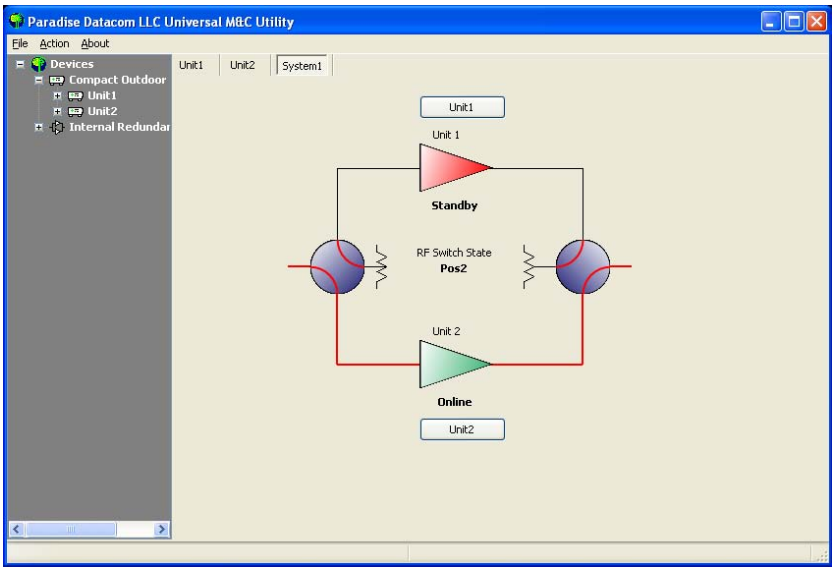

Figure 7-16: Control Panel showing Unit 1 faulted and signal routed to Unit 2

By clicking on the [Unit1] button (which will be labeled to correspond to the unit's name), the M&C Status window for Unit1 is activated, so the user may determine the cause of the fault. See Figure 7-17. Once the fault is cleared, Unit1 can be reactivated as the online unit by clicking on the triangular amplifier symbol for Unit2 in the System1 control panel.

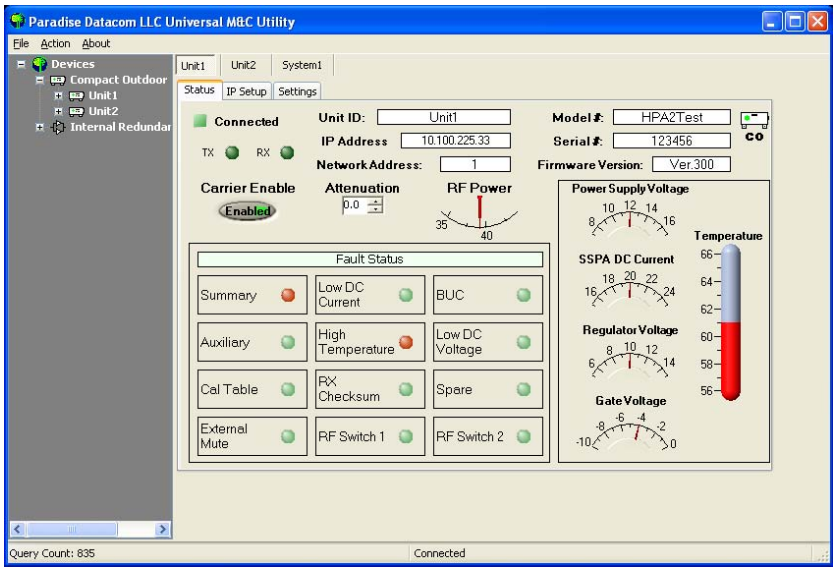

Figure 7-17: Unit1 Status panel showing Summary and Temperature Faults

If the redundant switch is manually rotated to the offline amplifier in a redundant system, an RF switch fault will occur. The system will not attempt to switch back to its original position. On the Redundancy Control Panel, both amplifiers will be colored red. The switch must be manually rotated back to the online amplifier.

7.1.2.3 PC Control using RS485 and Paradise M&C Software

Applications requiring long cable runs between the computer and the 1:1 Redundant System may use RS485 communication. The Compact Outdoor Amplifier's firmware supports networking on a RS485 bus. This type of network can be used to support the 1:1 Redundant System.

The RS485 link can typically be run up to 4000 ft. (1200 m) lengths. A good quality twisted pair cable should be used along with proper line terminations. There are no parallel end terminations in the amplifier's RS485 interface. Any required cable terminations have to be added externally. Either full or half duplex RS485 communication is supported. Schematics showing the proper wiring of each version are shown in Figures 7-18 and 7-19.

As in the stand-alone redundant system of Section 7.1.2.1, each Compact Outdoor SSPA must be programmed for Redundant System operation by using the RS-232 interface and M&C program. Similarly when networking SSPAs on a RS485 network, each amplifier's address must be set before they can communicate over the network. Both of these steps should be performed together as part of the initial system setup.

Figure 7-18 shows a typical 1:1 Redundant System with RS485 Full Duplex Communication. Figure 7-19 on the following page shows a typical 1:1 Redundant System with RS485 Half Duplex Communication.

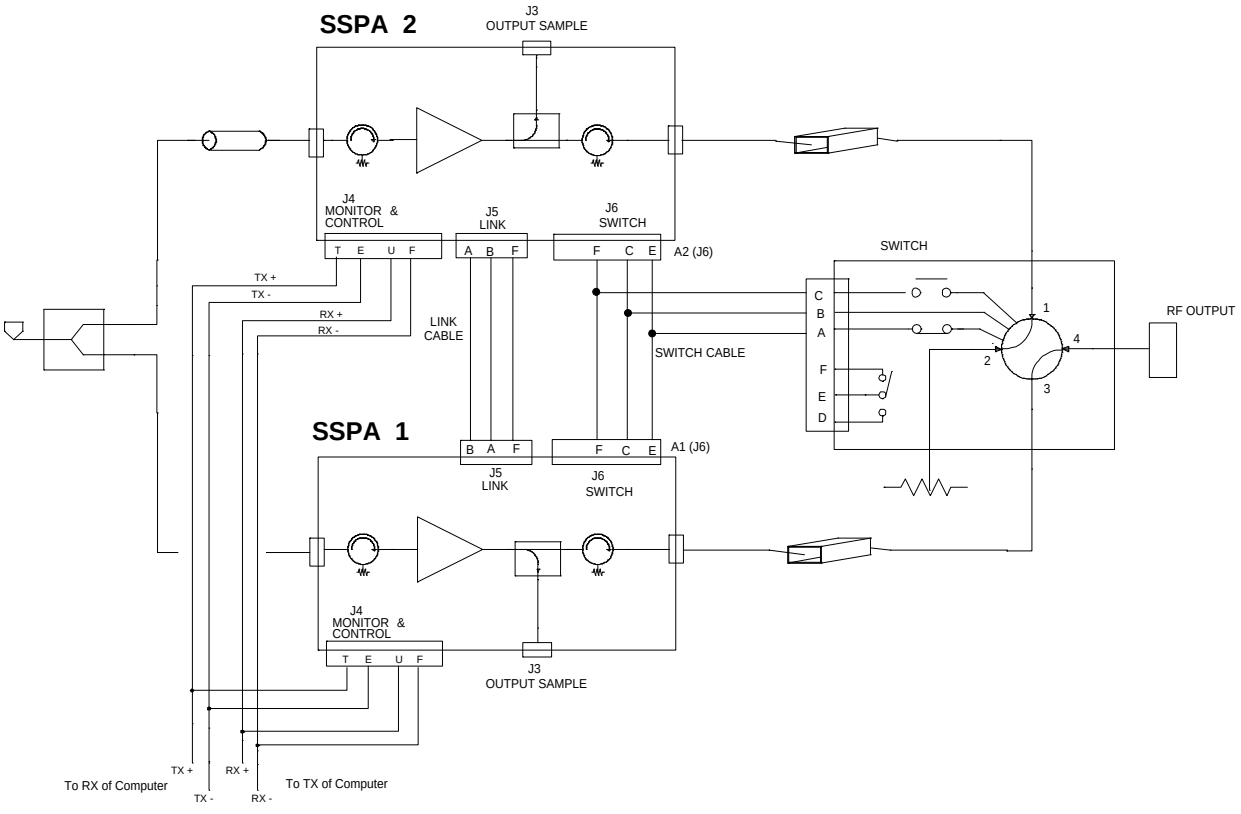

Figure 7-18: 1:1 Redundant System with RS485 Full Duplex Communication

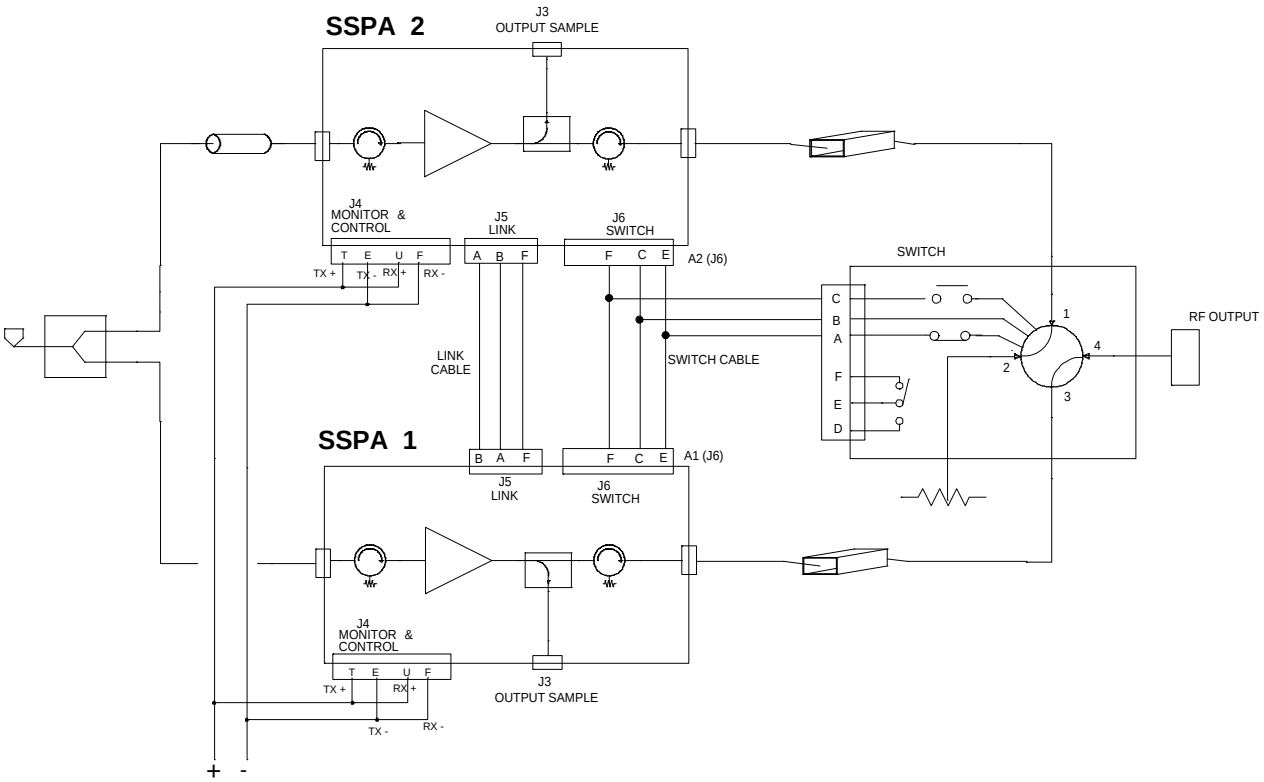

Figure 7-19: 1:1 Redundant System with RS485 Half Duplex Communication

7.2 1:2 Redundant Systems

The Compact Outdoor Amplifier can also be configured in 1:2 Redundant Systems. The major difference being that the amplifier's internal controller can not be used for system control. Instead a separate RCP2-1200 Redundant System controller is used to provide system control. The controller can be remotely located from the amplifiers up to 500 ft. Figures 7-20 through 7-23 show a 1:2 Compact Outdoor Amplifier Redundant System.

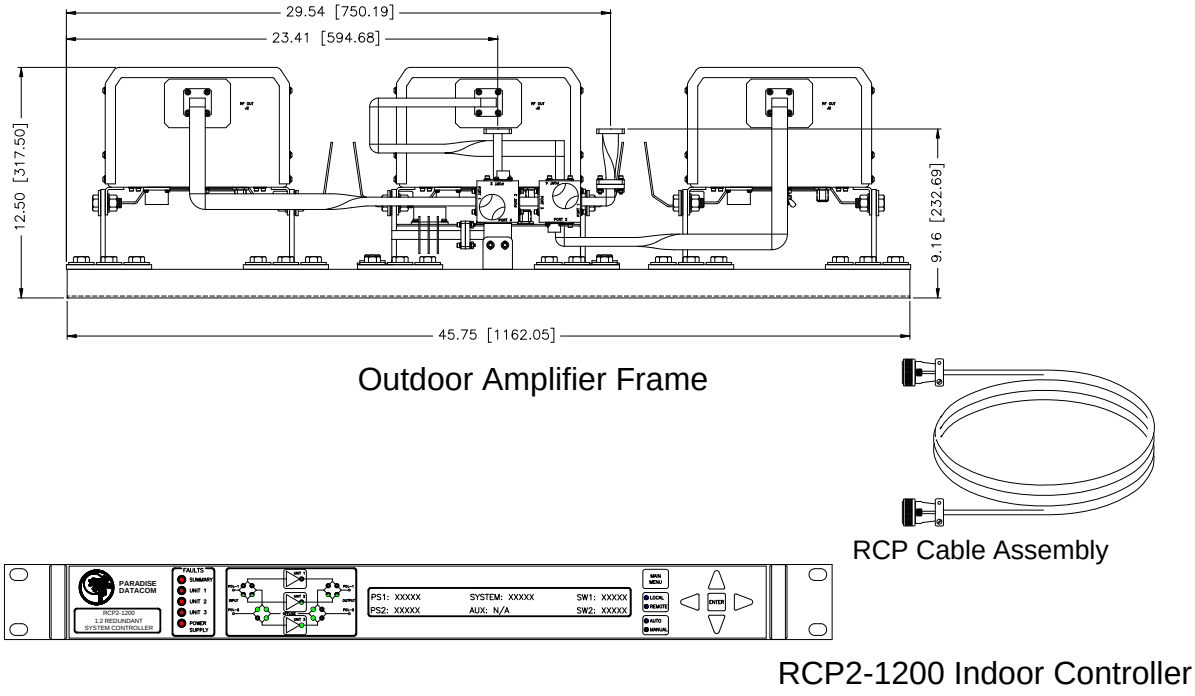

Figure 7-20: 1:2 Redundant System

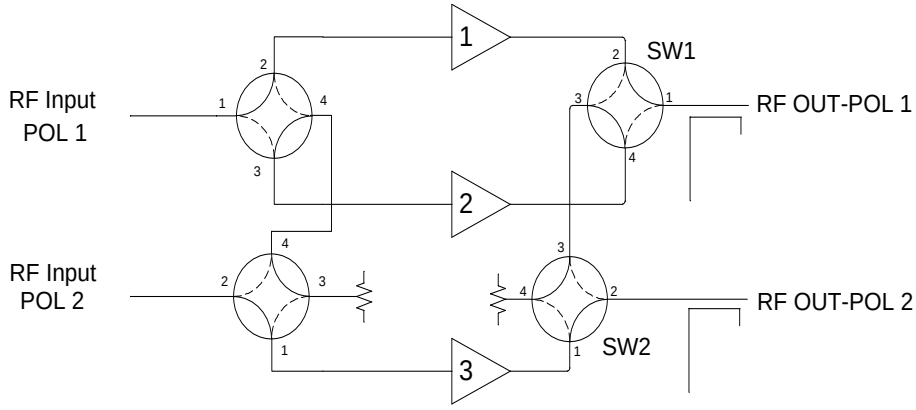

Figure 7-21: 1:2 Redundant System Block Diagram

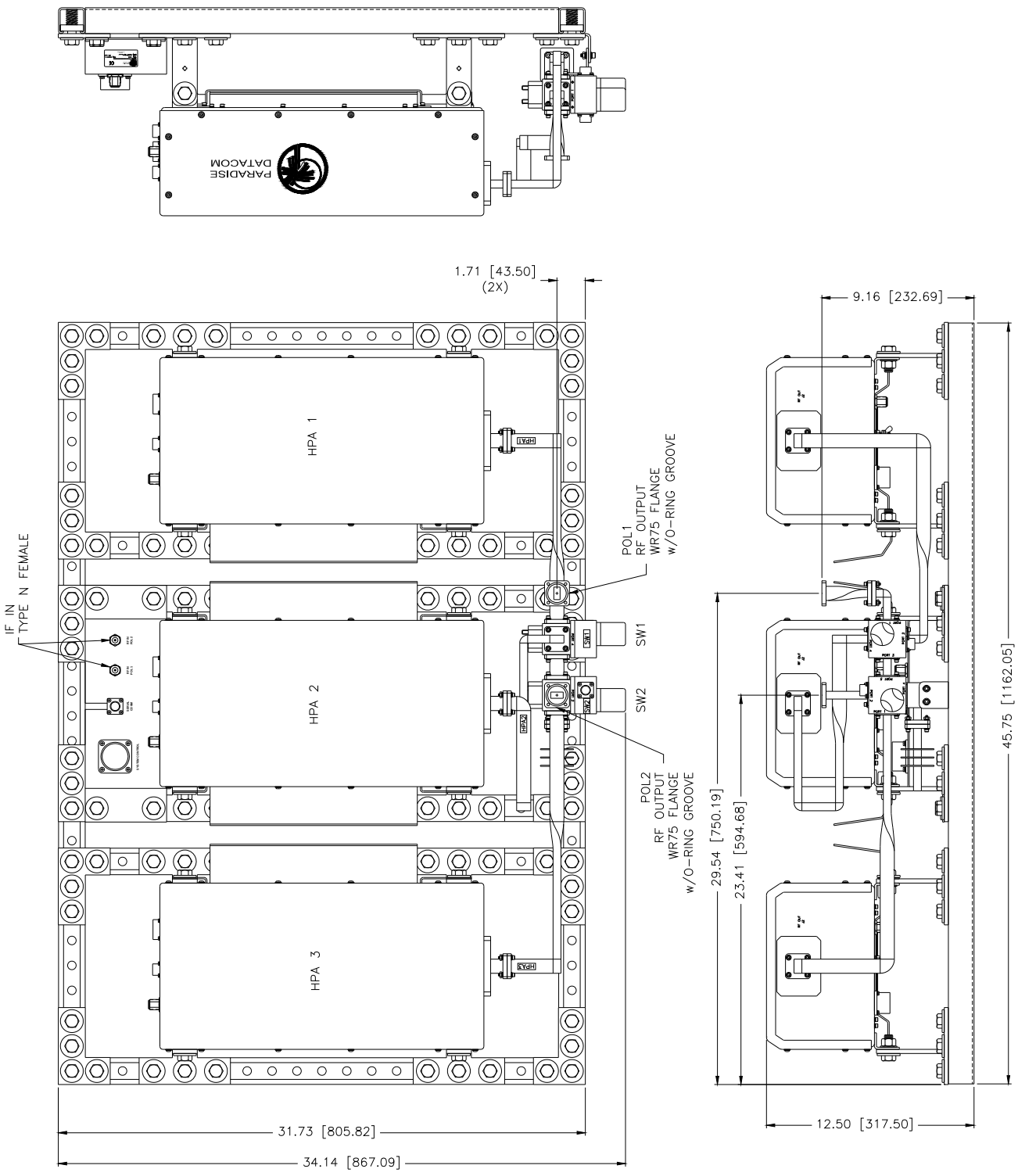

Figure 7-22: Outline, 1:2 Redundant System

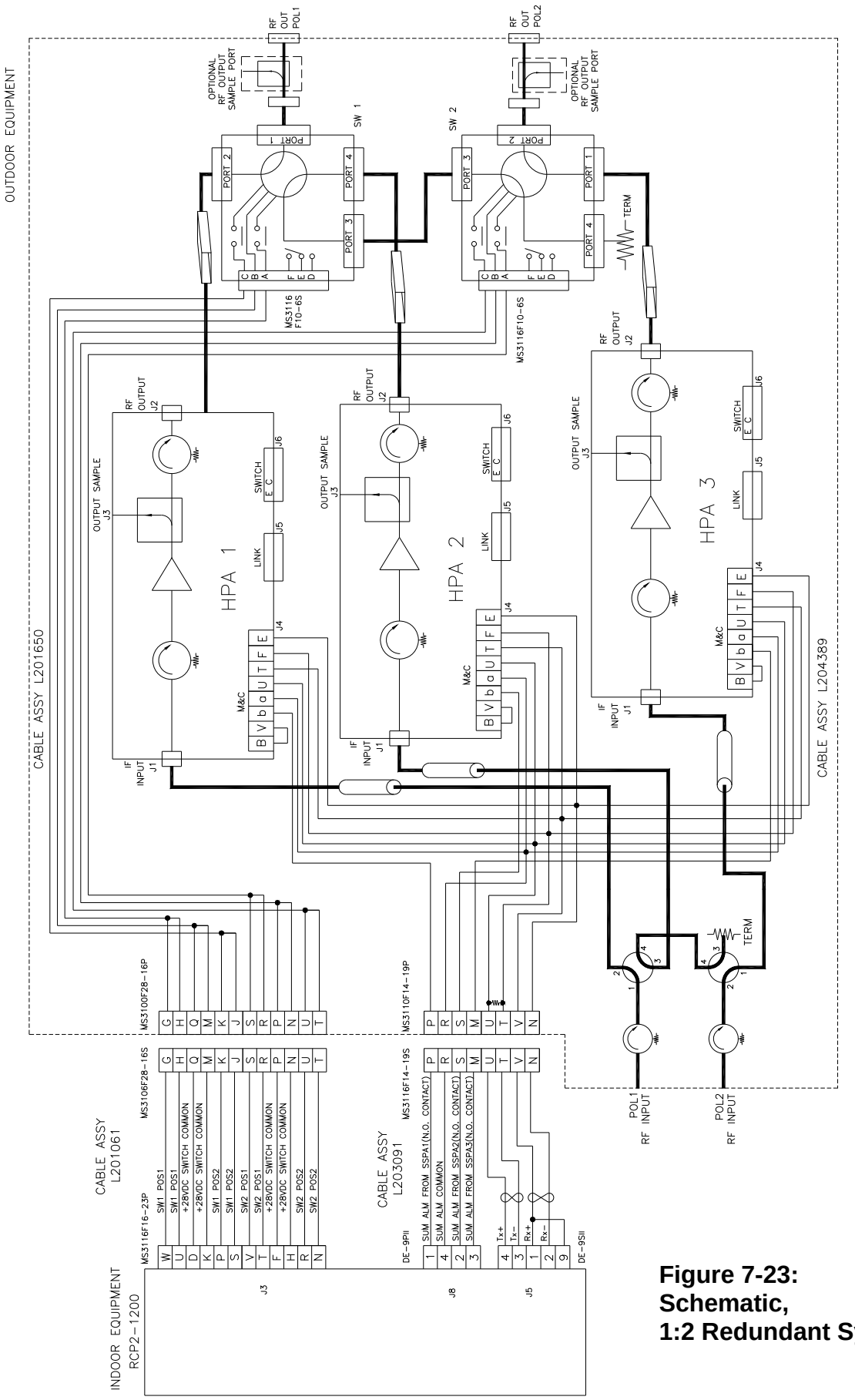

Figure 7-23: Schematic, 1:2 Redundant System

7.3 1:2 Redundant Systems with L Band Input

The 1:2 Redundant System with L Band Input can be configured with internal Block Up Converters that contain internal 10 MHz reference oscillators or configured for use with an external 10 MHz reference source. Systems configured with internal 10 MHz reference are straightforward extensions of the basic 1:2 architecture. Because the 10 MHz reference is integral to the converter there is no possibility of an interruption of the 10 MHz during switchover. Furthermore the standby amplifier always has 10 MHz reference and will not be faulted. Such a system is shown in Figure 7-24.

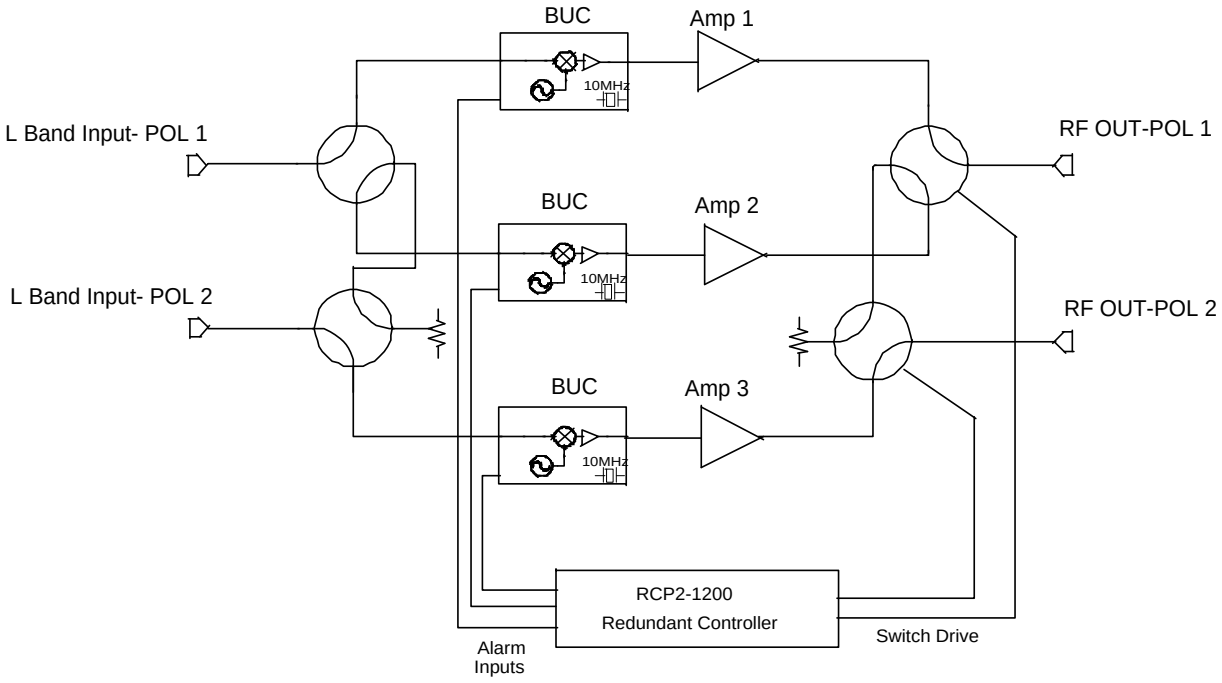

Figure 7-24: 1:2 Redundant System with L Band Input and Internally Referenced Block Up Converters (BUCs)

The Block Up Converters used in Satcom equipment typically use some form of phase locked local oscillator in the converter architecture. The Block Up Converter will signal an alarm condition whenever the oscillator looses phase lock. The amplifier will go into a mute state so that no spurious (off frequency) emissions can be transmitted to the satellite. The alarms from the BUCs and SSPAs are sent to the RCP2-1200 system controller which determines the proper switch conditions for the system.

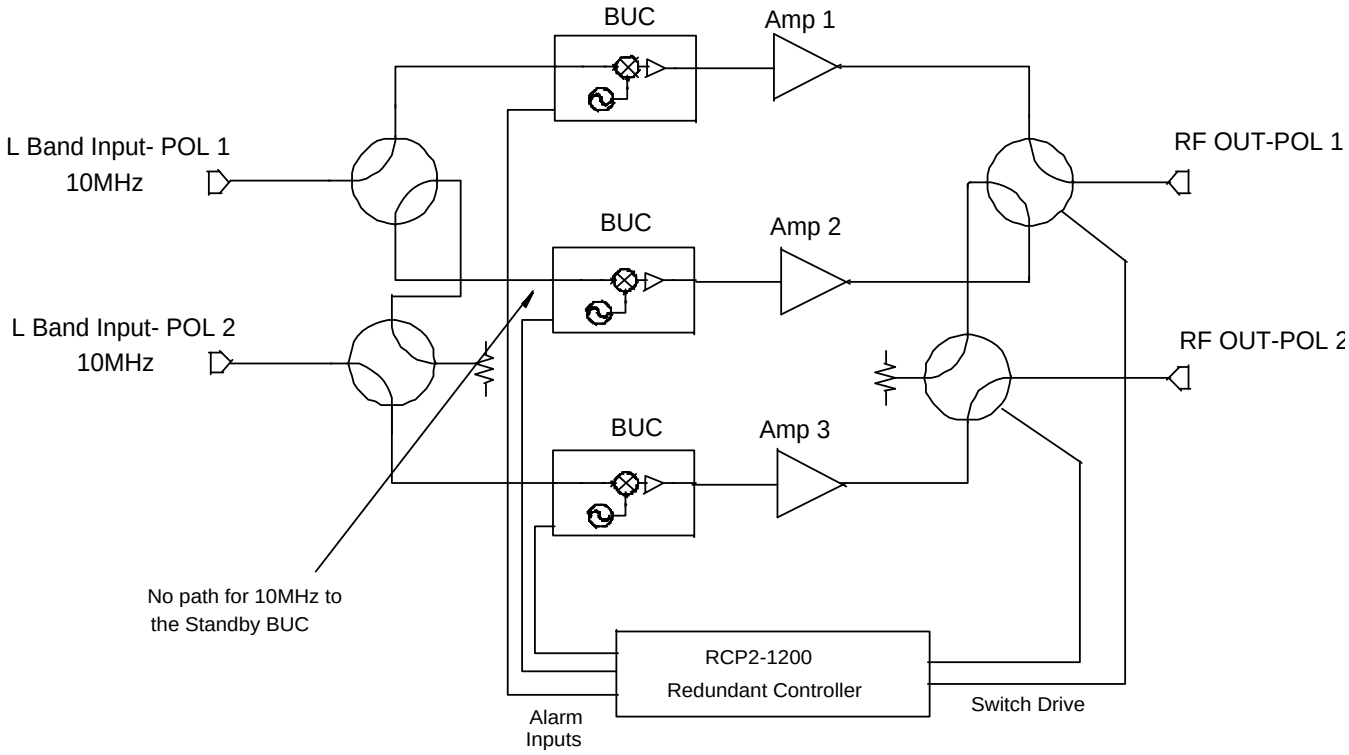

Figure 7-25: 1:2 Redundant System with External Reference showing the absence of 10 MHz reference to the stand-by BUC

A special case of the 1:2 Redundant System exists when an external reference is required of the system. With an external 10 MHz reference input on each polarity input to the system, the standby amplifier will not receive a reference signal and therefore would be in a faulted condition. In this state, the redundant controller will not allow the standby amplifier to come on line if a failure occurs with amplifier 1 or amplifier 3. See Figure 7-25.

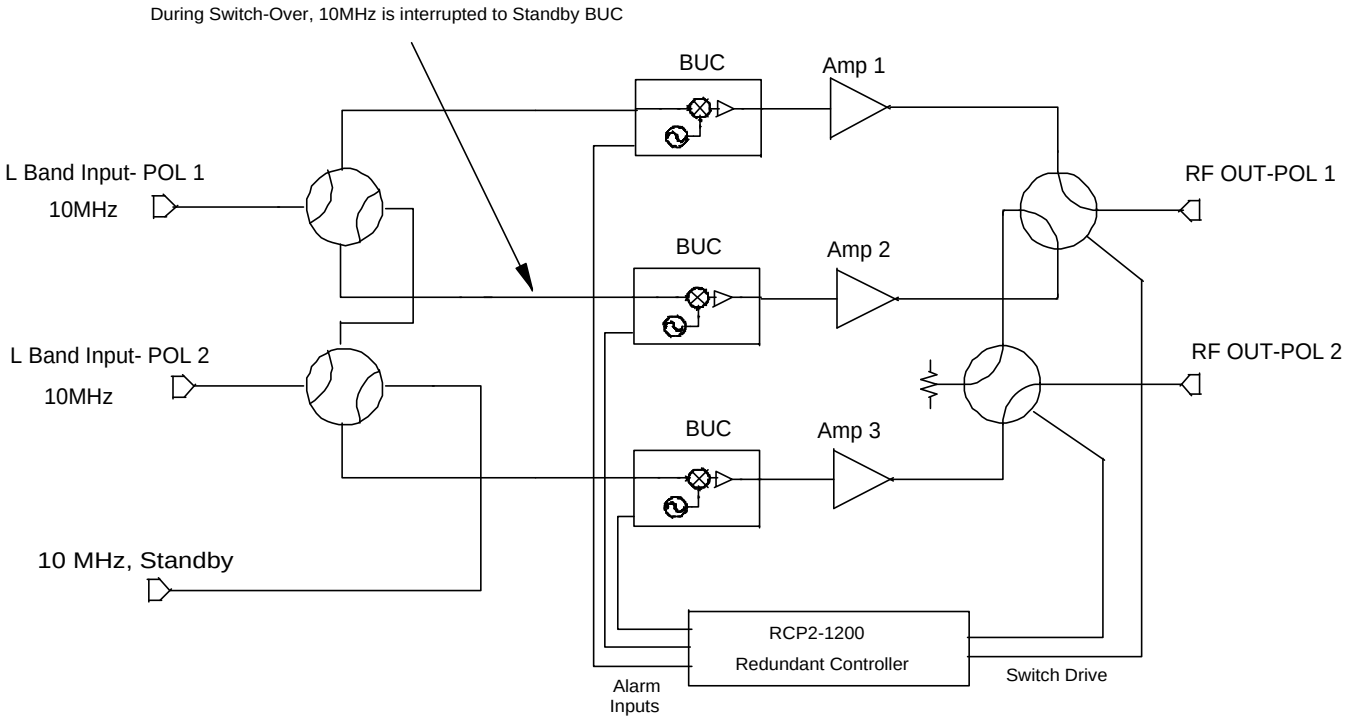

Figure 7-26: 1:2 Redundant System with (3) 10MHz inputs through the input switches. This arrangement allows for unreliable switch-over due to 10 MHz interruption to standby unit

At first it may be thought that a 10 MHz signal could be injected into the normally terminated port of the input switches. While in a normal operating state with all three BUCs operational this would work fine. However in the event of a failure of one of the on-line units, the 10 MHz would also be interrupted to the standby unit, as shown in Figure 7-26. Due to the quick determination of a unit fault, the controller will interpret a fault on the standby amplifier and reliable switchover can not be guaranteed.

To overcome the problems that result from interruption of the 10 MHz reference, it is imperative that the reference be injected in the system after the waveguide switches. One technique could be to install a multiplexer on the input of each amplifier that would allow the injection of the 10MHz reference. In this case a separate 10 MHz line would have to be run to the system and a three way splitter could distribute the reference to each amplifier.

The standard Paradise Datacom configuration overcomes this issue by using a Reference Combiner assembly.

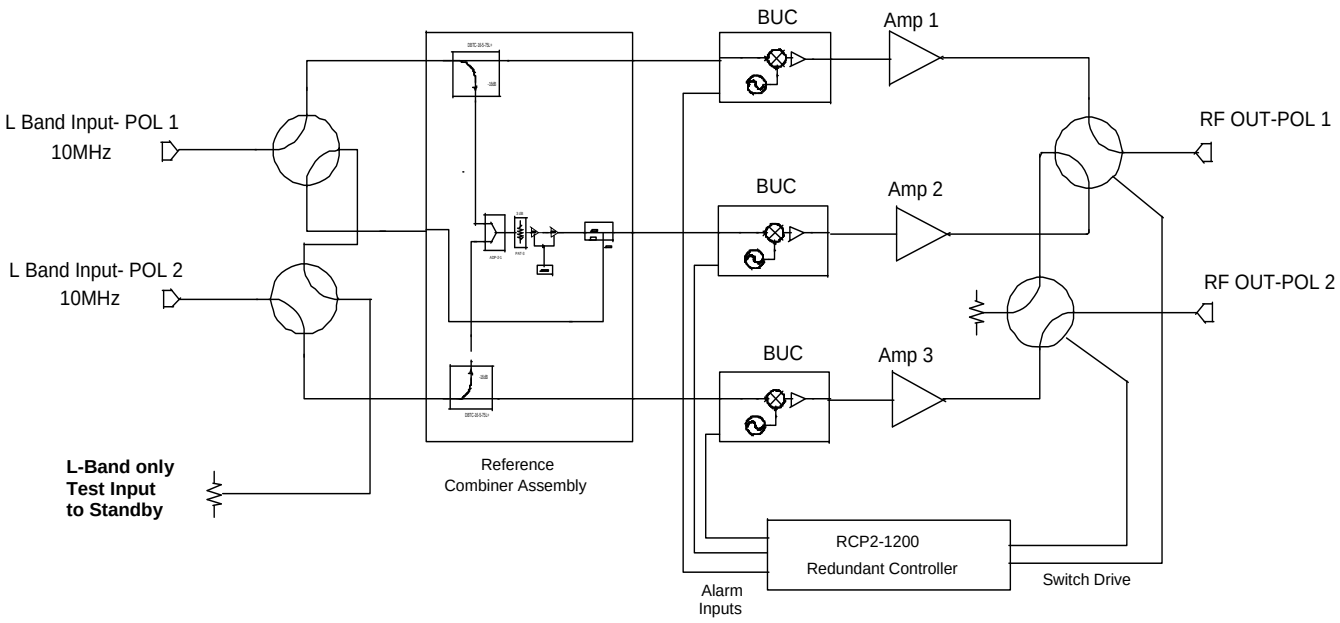

Figure 7-27: Standard 1:2 Redundant System with External 10MHz Reference using the Reference Combiner Assembly.

The Reference Combiner assembly, as shown in Figure 7-27, couples a sample of the 10 MHz reference from each of the two polarity inputs. It will then supply the standby amplifier with the reference from either of the two inputs. The reference combiner will arbitrate and decide which 10 MHz signal to supply to the standby amplifier. It will not supply both 10 MHz sources to the standby amplifier. This allows all three amplifiers to be in a normal operating (non faulted) condition and the RCP2-1200 controller can operate the system in normal 1:2 redundancy. This eliminates the need for a separate 10 MHz line going to the system as the 10 MHz reference normally exists on each L-Band cable.

Amp 2 is meant to be the standard stand-by amplifier in this configuration. Should Amp 1 or Amp 3 fault, the RCP2-1200 will automatically switch to the stand-by Amp 2. However, when this occurs, this interrupts the 10 MHz reference to the faulted Amp/BUC, which results in a constant BUC fault on that thread. In order to return Amp 2 to the stand-by state, the user will need to clear the fault, switch to manual mode on the RCP2-1200 and then select Amp 2 as stand-by. Table 7-1 gives a step-by-step guide to returning Amp 2 to stand-by status.

Table 7-1: Returning Amp 2 to Stand-by Mode After Fault on Thread 1 or 3

Step	Action
1	Fault on Thread 1 or Thread 3 causes switchover to Thread 2
2	Determine cause of fault on Thread 1 or Thread 3 and remove fault condition
3	Switch to Manual mode on RCP2-1200
4	Select Amp 2 as stand-by amplifier
5	Switch to Auto mode on RCP2-1200

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8.0 Phase Combining Overview

Phase combining amplifiers has long been a popular means of increasing the output power of an amplifier system. Under high power microwave conditions it is common to utilize some form of waveguide hybrid coupler to combine the output power of two amplifiers. This coupler is generally a waveguide tee such as a four port magic tee. On the input side, common coaxial power splitters can be utilized to divide the power due to the lower power levels at the input of the system. Figure 8-1 shows a typical block diagram of a phase combined amplifier pair. As long as the electrical delay, phase and amplitude of the two paths are kept within close tolerance of each other, the output power of the system will be twice the output power (+3dB) of a single amplifier.

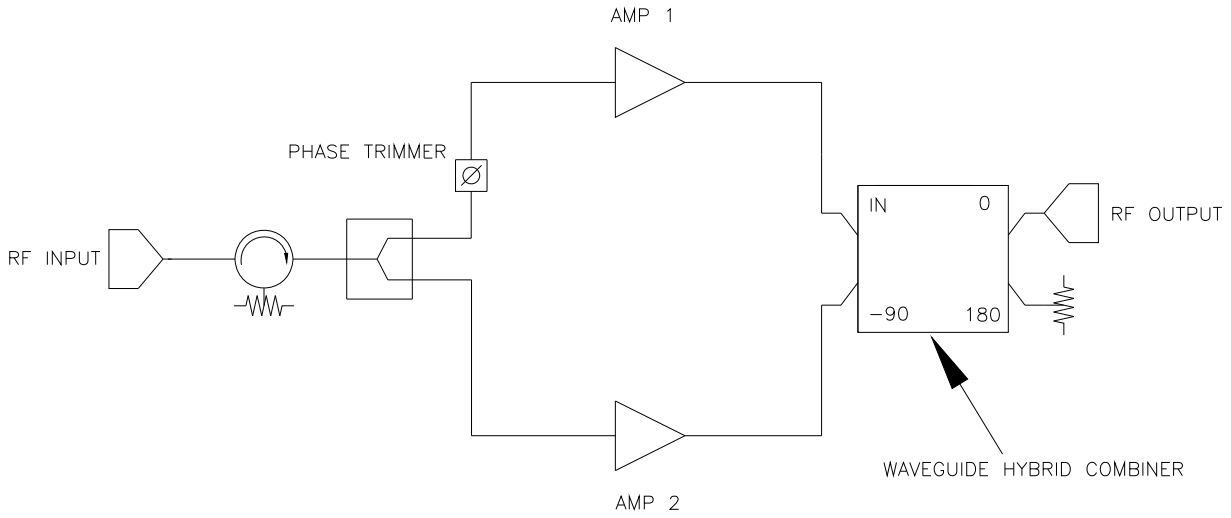

Figure 8-1: Phase Combined Amplifier System

The main drawback of this approach is that in the event of an amplifier failure, the total output power decreases by 6 dB, or a factor of 4. This does not offer the system much in the way of redundant capability with such a large decrease in output power capability. The power decrease is due to the fact that with only one amplifier active, the output combiner acts as a power divider. The output power from the remaining amplifier is divided between the output of the system and the terminated port of the hybrid combiner. Thus only one half of the power from one amplifier reaches the output port which is 6 dB less than the combined output power from both amplifiers. A high power system requiring a degree of redundancy needs some means of bypassing the combiner in the event of an amplifier failure. This would allow the full output power capacity of the remaining amplifier to reach the output. In this case the total RF output power would only decrease by 3 dB from the phase combined output power. A 3 dB reduction in output power is generally more tolerable to a system's link budget thereby giving the system a degree of redundancy.

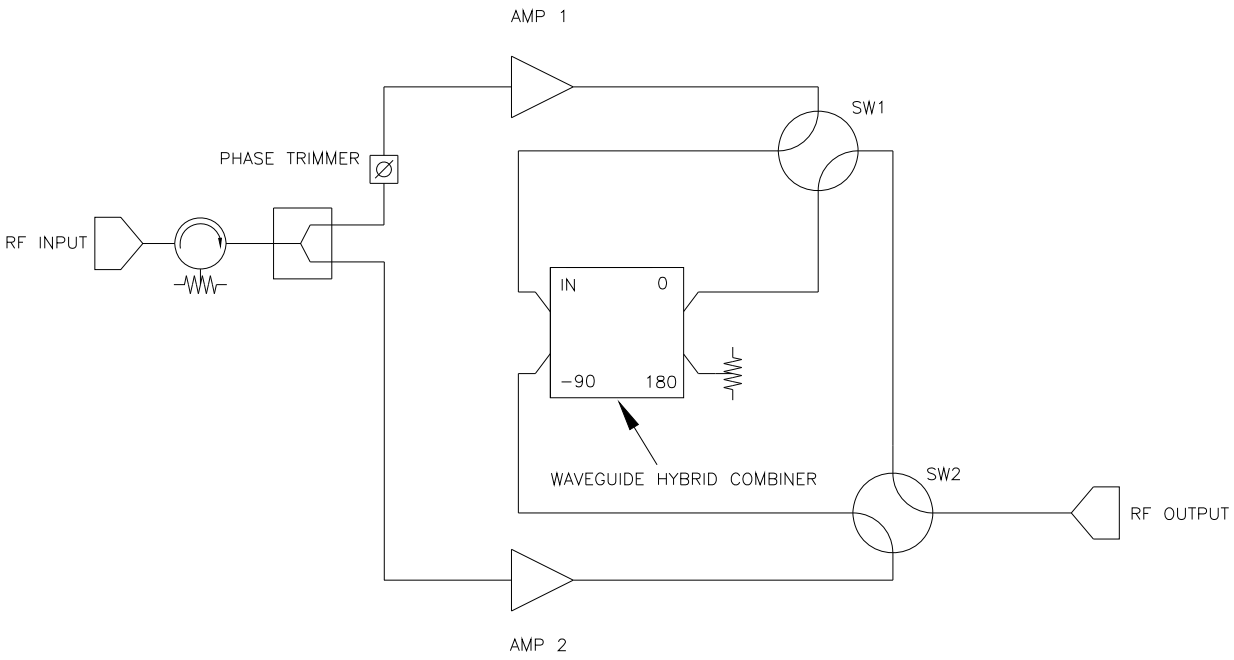

Figure 8-2: 1:1 Fixed Phase Combined System with FPRC-1100 controller

A technique has been developed which accomplishes phase combining and provides redundancy with two waveguide transfer switches. A block diagram of such a system is shown in Figure 8-2.

This type of system is sometimes referred to as a “Fixed Phase” combined system to differentiate it from the Variable Phase Combiner (VPC) systems commonly used with TWTAs. In the 1:1 Fixed Phase Combined system, the waveguide switches allow the amplifier outputs to either be directed into the combiner or bypass the combiner and connect directly to the RF output.

Paradise Datacom has developed a series of controllers that greatly enhances the operation of the phase combined system. The FPRC-1100 Phase Combined System Controller is designed specifically to control 1 for 1 Fixed Phase Combined redundant amplifier systems. The FPRC-1200 Phase Combined System Controller allows remote control of 1 for 2 Fixed Phase Combined redundant amplifier systems.

Each controller can be used in either manual or automatic mode to monitor the system amplifiers for faults and operate the transfer switches. The controller has a very user friendly interface that allows the operator to monitor the composite output power of the system and adjust the gain of the amplifiers in 0.1 dB increments over a 20 dB range. The controller adjusts each amplifier in the system and keeps the amplitude of each balanced for optimal

power combining. To the operator, the system appears as a single amplifier. The operator can choose between using the system as a phase combined system or a traditional redundant system.

8.1 1:1 Fixed Phase Combined System Components

An outline drawing of a 1:1 Fixed Phase Combined Amplifier assembly is shown in Figure 8-3 on the following page. The system consists of:

(1) Amplifier Base Assembly, which comprises:
- (1) Mounting Base (Frame or Plate)
- (2) Compact Outdoor SSPAs
- (1) Waveguide Switch Assembly
- (1) Signal Box Assembly
- (2) Cable Assemblies between SSPAs and Signal Box

(1) FPRC-1100 1:1 Phase Combined Redundant Controller
(2) Cable Assemblies between Signal Box and FPRC-1100
(2) AC line cables
(1) Quick Start RS-232 Cable for test / debug

The Amplifier Base Assembly is typically shipped intact. Verify that the hardware is securely tightened for each Compact Outdoor amplifier and make sure to observe the amplifier's position indicator. If facing the RF Output end of the amplifiers, HPA 1 should be on the left hand side and HPA 2 should be on the right hand side as shown in Figure 8-3.

Verify that the connections of the Waveguide Switch Assembly mate with the proper SSPA.

8.1.1 Signal Box Assembly

The Signal Box Assembly contains the RF input isolator and splitter that routes the RF to each amplifier. It also routes the monitor and control signals from each amplifier back to the FPRC-1100 system controller.

The signal box also contains a phase shifter. This phase shifter is in cascade with the RF input to HPA 1. This allows the system to achieve optimum power combining and is factory set for optimum combining across the full bandwidth of the amplifier. It should not normally require adjustment in the field unless and amplifier has been replaced.

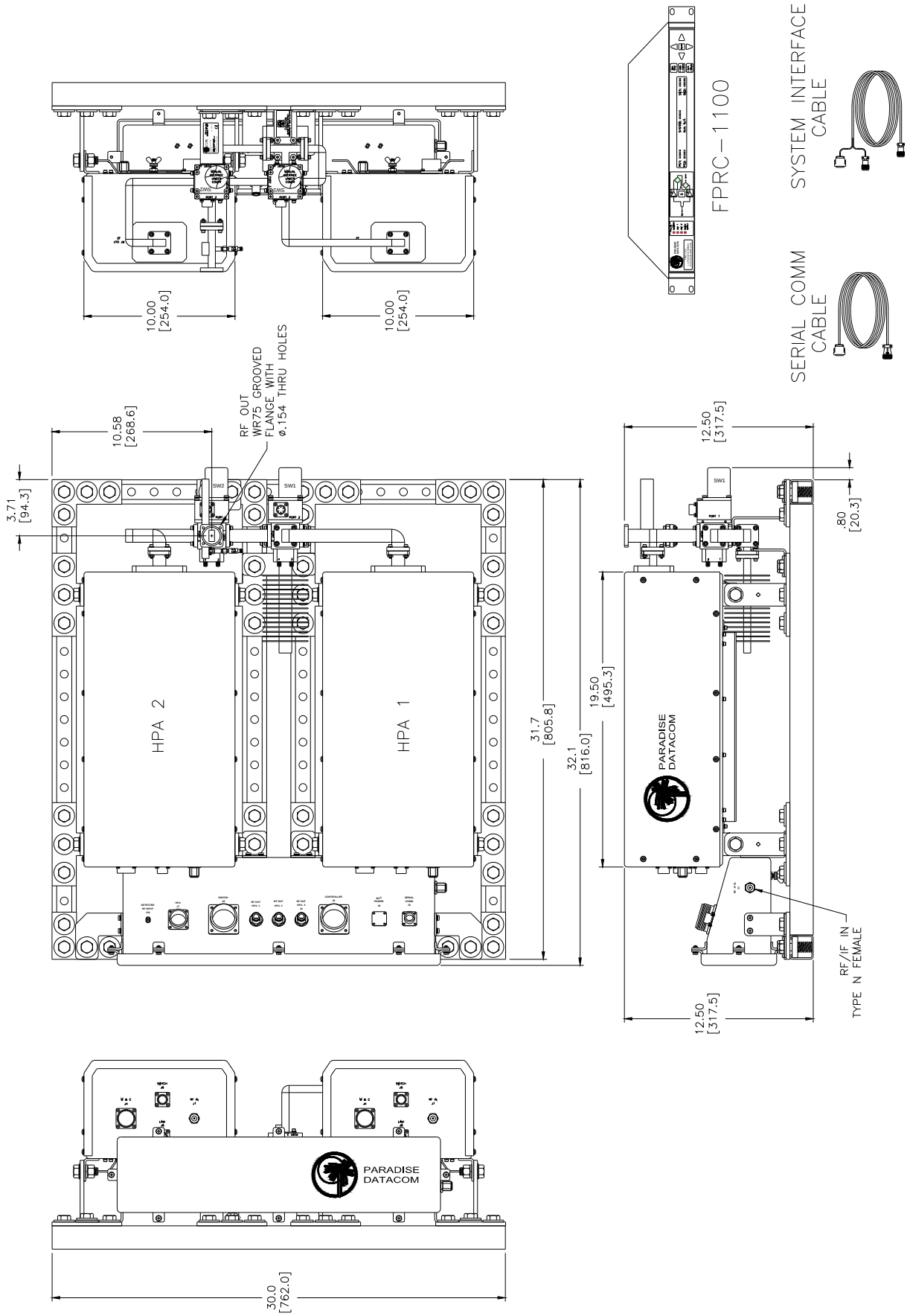

Figure 8-3: Outline, 1:1 Fixed Phase Combined System

8.2 1:1 Fixed Phase Combined System Operation with the FPRC-1100

Under normal system operation, both HPA 1 and HPA 2 are on-line. Their output power is combined at the magic-tee waveguide combiner. The waveguide combiner has an integral RF sampler that provides a sample of the RF output sample at -40 dBc. This port feeds an RF attenuator/diode detector combination. The detector's output voltage is sent back to the Signal box via a coaxial cable and linked to the FPRC-1100 Redundant Controller.

The FPRC-1100 is a 1 RU high indoor controller that can remotely monitor and control the 1:1 Fixed Phase Combined system. The controller has a very user friendly interface that allows the operator to monitor the composite output power of the system and adjust the gain of the amplifiers in 0.1 dB increments over a 20 dB range. The controller adjusts each amplifier in the system and keeps the amplitude of each balanced for optimal power combining.

The FPRC-1100 can be used in automatic or manual mode. In manual mode if a fault occurs in one of the amplifiers, a fault will be indicated on the front panel but no waveguide switch change will occur. In automatic mode the controller will determine the appropriate waveguide switch positions and switch the remaining two amplifiers on line. This will ensure that the system is operating at full output power capability.

Figure 8-4: FPRC-1100 Phase Combined System Controller

The FPRC-1100 front panel is shown in Figure 8-4. In most cases the user will place the controller in Auto mode so that the controller can determine the proper switch position in the event of an amplifier failure. The mimic display shows the position of each waveguide switch by lighting an LED in the waveguide switch path.

Detailed information on the installation and operation of the FPRC-1100 can be found in the unit's operations manual, Paradise Datacom drawing #205933.

8.3 1:1 Fixed Phase Combined System with L-Band Input

The basic 1:1 Fixed Phase Combined system topology is very similar to a 1:1 redundant system and is shown in Figure 8-5. When in Automatic mode the waveguide switches (S1& S2) either direct the each amplifier output to the waveguide phase combiner or, if lower output power is required, bypass the combiner and send an individual amplifier output to the system output. The system shown in Figure 8-5 utilizes a chain redundancy in which the faults for BUC1 and HPA1 are linked, as are BUC2 and HPA2 faults.

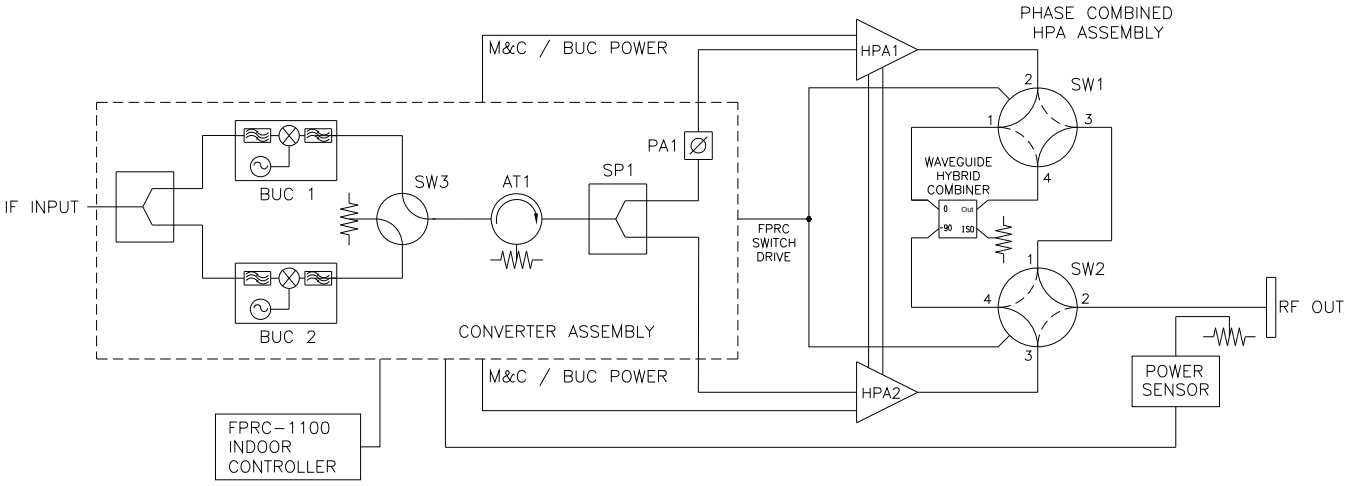

Figure 8-5: 1:1 Phase Combined System with HPA control of BUC redundancy

If a fault were to occur with either component in the chain, both components would be treated as faulted, and would cause a switchover to the operational chain. If the system is operating in phase combined mode and a BUC or amplifier enters a fault condition, the system will switch to the operational thread. This provides a soft fail mode and results in a power decrease of 3dB to the system output power.

The BUC switch (SW3) is part of the converter assembly and is not controlled by the FPRC. This switch is driven by the amplifiers when a fault is detected and will be driven to place the operational BUC online without user intervention.

The system utilizes a chain redundancy architecture for fault handling. If a fault occurs in a BUC or SSPA, the system will switch to the operational chain. This offers redundancy in the L-Band portion as well as the SSPA portion of the system.

This system may also be operated via manual mode. This mode of operation may offer some benefits over automatic operation. When in manual mode, the amplifiers will not switch out of Phase Combined Mode or switch to the operational amplifier without user intervention if an HPA fault occurs.

However, if a BUC fault occurs, the HPAs will direct Switch 3 to place the operational BUC online. The fault indication will still be present on the front panel of the FPRC, but the system output would be unaffected by the fault, thus indicating to the user that the failure is with the BUC and not the HPA.

8.3.1 1:1 Fixed Phase Combined System with L-Band Input Components

An outline drawing of a 1:1 Fixed Phase Combined Amplifier with L-Band Input assembly is shown in Figure 8-6 on the following page. The system consists of:

(1) Amplifier Base Assembly, which comprises:
- (1) Mounting Base (Frame or Plate)
- (2) Compact Outdoor SSPAs
- (1) Waveguide Switch Assembly
- (1) Signal Box Assembly with 1:1 Redundant Block Up Converter System
- (2) Cable Assemblies between SSPAs and Signal Box

(1) FPRC-1100 1:1 Phase Combined Redundant Controller
(2) Cable Assemblies between Signal Box and FPRC-1100
(2) AC line cables
(1) Quick Start RS-232 Cable for test / debug

8.3.2 Signal Box Assembly

The Signal Box Assembly contains the Redundant BUC Assembly including the coaxial switch, the RF input isolator and splitter that routes the RF to each amplifier. It also routes the monitor and control signals from each amplifier back to the FPRC-1100.

The signal box also contains a phase shifter. This phase shifter is in cascade with the RF input to HPA 1. This allows the system to achieve optimum power combining and is factory set for optimum combining across the full bandwidth of the amplifier. It should not normally require adjustment in the field unless and amplifier has been replaced.

8.3.3 Redundant BUC Operation

The 1:1 Fixed Phase Combined System with L-Band Input is built utilizing a chain redundancy architecture. This means if a Block Up Converter which is connected in series with an SSPA fails, the SSPA will also fault. This will disable the system's ability to phase combine until the fault with the BUC is corrected.

Note: With the addition of an RCP2-1100, the BUCs can function as an independent, fully redundant 1:1 system that is not affected by the 1:1 phase combined SSPA's status.

8.3.4 Identifying a BUC Fault vs. SSPA Fault

In the event an SSPA or BUC would cause a fault, the FPRC-1100 will show this as a summary alarm on the front panel. The BUC fault is recognized by the SSPA via the Auxiliary Alarm input to the SSPA. The SSPA will recognize this fault as a Major Fault, and will switch the BUC offline, along with itself.

In order to identify which device is faulted, access the system information screen on the FPRC-1100. Scroll down until the screen displays the EXT FAULT: AUX FAULT section. If BUC 1 is faulted, the Auxiliary Fault will display AUX11101. If BUC 2 is faulted, the Auxiliary Fault will display AUX11110. If the Auxiliary Fault displays AUX11100 then no BUC fault is present and the fault is with the SSPA. The faulted SSPA is identified by the red LED on the front panel of the FPRC-1100.

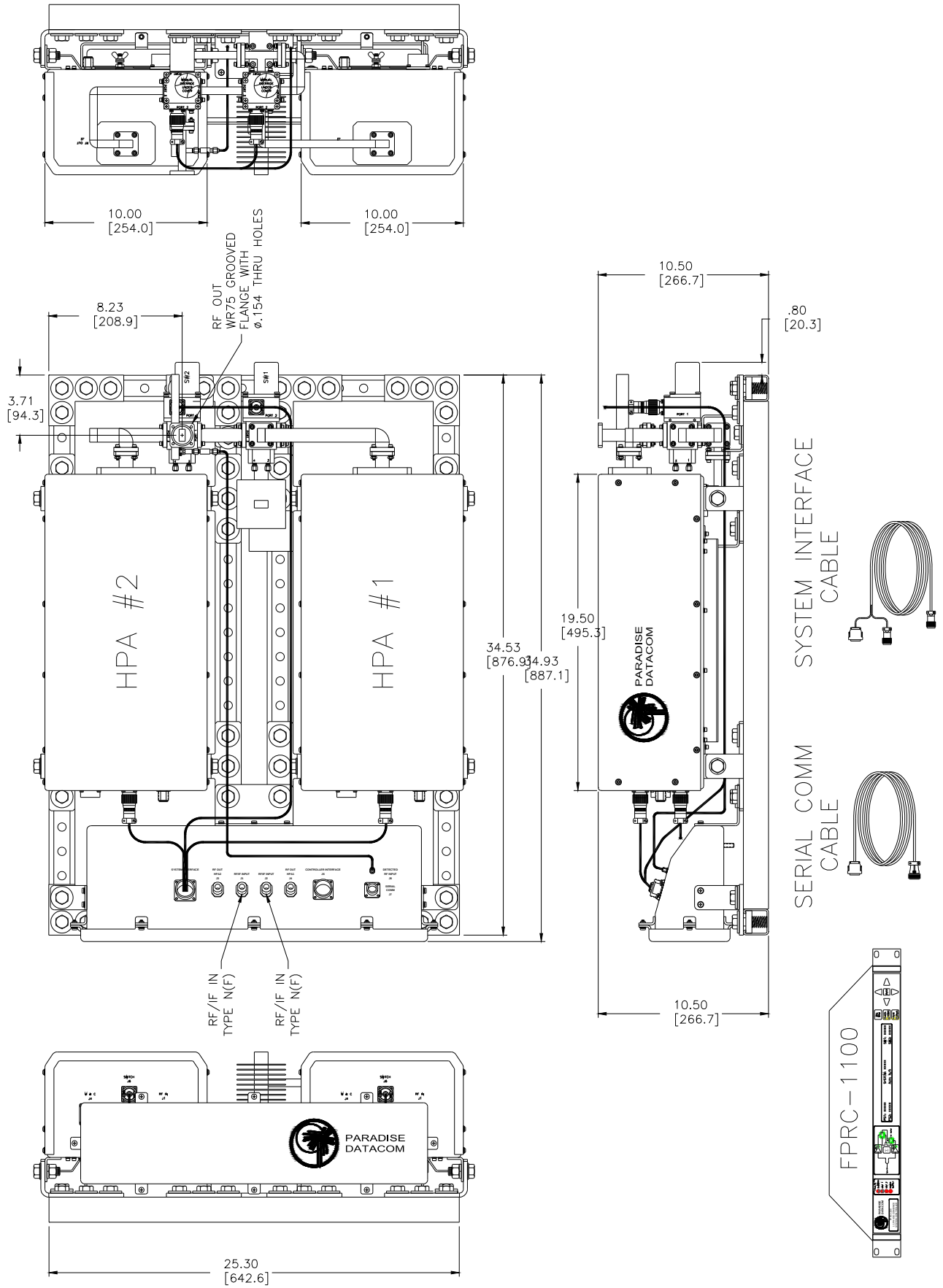

Figure 8-6: Outline, 1:1 Fixed Phase Combined System with L-Band Input

8.3.5 Adjusting the Phase Combining

The system is phase adjusted for optimum performance across the frequency band at the factory, and no adjustments are typically needed except in the event that a SSPA has been replaced.

The SSPAs are manufactured to a delay specification, but an adjustment may be necessary to achieve the best operation in the system. After the new SSPA has been placed in the system, apply power to the system and enable both amplifiers. Apply a CW signal source to the input of the system and monitor the output power on the FPRC-1100 LCD screen.

Measure the power out of the system with a single CW carrier (mid-band) applied to the input. Remove the cover from the Signal Box and loosen the locking nut on the phase adjuster (7/16”) and slowly rotate the knob clockwise. Continue to rotate the knob until the output power is peaked.

For optimum performance across the entire frequency range of the SSPA system, choose another frequency near each band edge and repeat the steps above. It may be necessary to find the best compromise in output power for broadband use.

The BUCs are outside the phase combined loop. Therefore, replacing a BUC will not impact the phase combining of the system, and no adjustment of the phase shifter is necessary.

Securely fasten the cover back on to the Signal Box.

8.4 1:2 Fixed Phase Combined Systems

The 1:2 Fixed Phase Combined Redundant System is a popular system architecture that enables Solid State Power Amplifiers to achieve higher output power levels while building in full-power redundancy. The basic system topology is similar to a 1:2 redundant system and is shown in Figure 8-7.

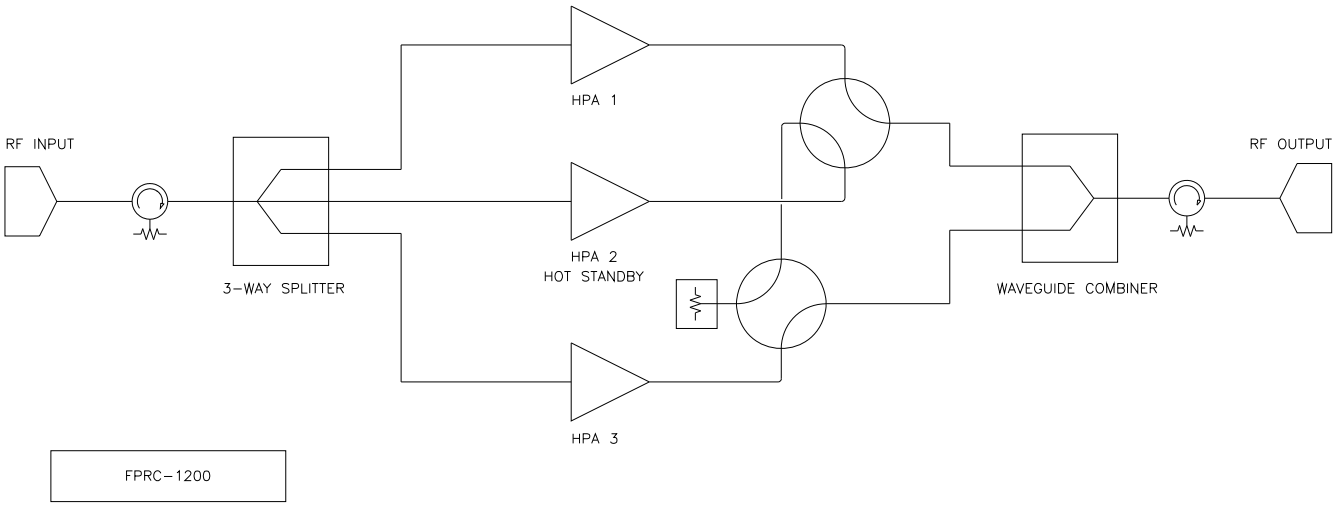

Figure 8-7: Block Diagram, 1:2 Fixed Phase Combined System

In this system, amplifiers 1 and 3 are normally online. The outputs of 1 and 3 are directed by the waveguide switches into a fixed phase combiner such as a waveguide “magic tee” style combiner. In the event of a failure of either on line amplifier, the standby amplifier, 2, can be switched in place of either 1 or 3 and the system maintains full output power.

The 1:2 Fixed Phase Combined Amplifier System can be configured with any of the Compact Outdoor Amplifiers listed in Appendix E in either C or Ku band. The output power of the system is two-times the output power of the single SSPA.

System designers find that the 1:2 Fixed Phase Combined Amplifier System topology is a very cost effective solution to realizing higher power amplifier systems. For example, it is less expensive to configure a 1 kW C-Band redundant system using (3) 500W Compact Outdoor Amplifiers in a 1:2 Fixed Phase Combined redundant system than it is to use (2) 1 kW amplifiers in a traditional 1:1 Redundant System.

8.4.1 1:2 Fixed Phase Combined System Components

An outline drawing of a 1:2 Fixed Phase Combined Amplifier assembly is shown in Figure 8-8. The system consists of:

(1) Amplifier Base Assembly, which comprises:
- (1) Mounting Base (Frame or Plate)
- (3) Compact Outdoor SSPAs
- (1) Waveguide Switch Assembly
- (1) Signal Box Assembly with Integrated Block Upconverters
- (2) Cable Assemblies between SSPAs and Signal Box

(1) FPRC-1200 1:2 Phase Combined Redundant Controller
(2) Cable Assemblies between Signal Box and FPRC-1100
(3) AC line cables
(1) Quick Start RS-232 Cable for test / debug

The Amplifier Base Assembly is typically shipped intact. Verify that the hardware is securely tightened for each Compact Outdoor amplifier and make sure to observe the amplifier’s position indicator. If facing the RF Output end of the amplifiers, HPA 3 should be on the left hand side, HPA 2 should be in the center, and HPA 1 should be on the right hand side as shown in Figure 8-8.

Verify that the connections of the Waveguide Switch Assembly mate with the proper SSPA.

The FPRC-1200 controller is a 1 RU external controller specifically designed to handle such an amplifier system. It not only handles all traditional fault monitoring and switching duties, but also provides an overall system monitor and control facility.

8.4.2 Signal Box Assembly

The Signal Box Assembly contains the RF input isolator and three way splitter that routes the RF to each amplifier. It also routes the monitor and control signals from each amplifier back to the FPRC-1200 system controller.

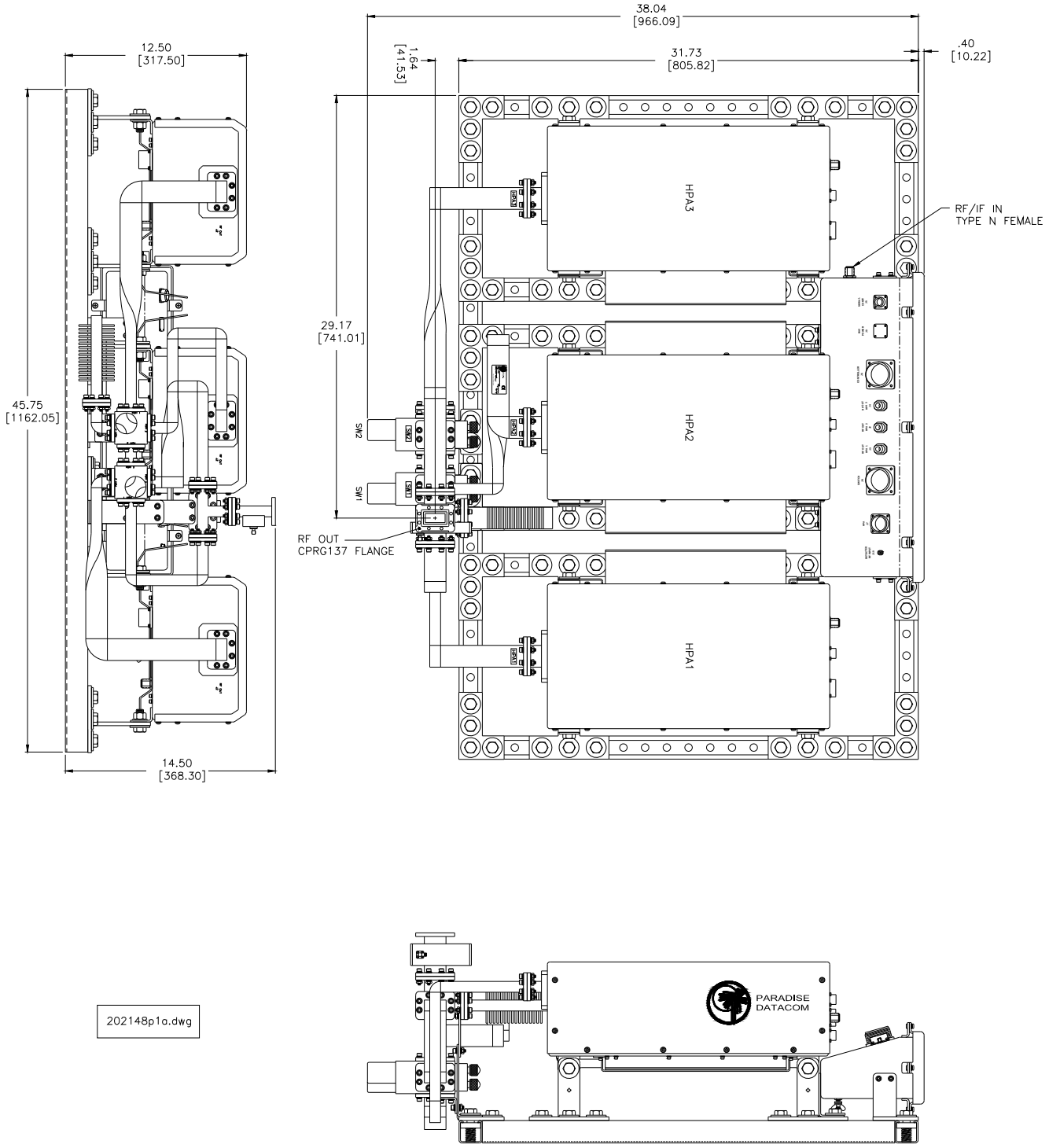

Figure 8-8: Outline, 1:2 Fixed Phase Combined System

The Signal Box also contains two phase shifters. These phase shifters are in cascade with the RF input to HPA 1 and HPA 3. These allow the system to achieve optimum power combining and are factory set for optimum combining across the full bandwidth of the amplifier. They should not normally require adjustment in the field unless and amplifier has been replaced.

8.5 1:2 Fixed Phase Combined System Operation with FPRC-1200

Under normal system operation, HPA 1 and HPA 3 are on-line. Their output power is combined at the magic-tee waveguide combiner. The waveguide combiner has an integral RF sampler that provides a sample of the RF output sample at -40 dBc. This port feeds an RF attenuator / diode detector combination. The detector's output voltage is sent back to the Signal box via a coaxial cable and fed to the FPRC-1200 Redundant Controller.

The 1:2 Fixed Phase Combined System is controlled by an FPRC-1200 1:2 external Redundancy Controller. Detailed information on the installation and operation of the FPRC-1200 can be found in the unit's operations manual, Paradise Datacom drawing #201138.

The FPRC-1200 can be used in automatic or manual mode. In manual mode if a fault occurs in one of the amplifiers, a fault will be indicated on the front panel but no waveguide switch change will occur. In automatic mode the controller will determine the appropriate waveguide switch positions and switch the remaining two amplifiers on line. This will ensure that the system is operating at full output power capability.

The FPRC-1200 front panel is shown in Figure 8-9. In most cases the user will place the controller in Auto mode so that the controller can determine the proper switch position in the event of an amplifier failure. The mimic display shows the position of each waveguide switch by lighting an LED in the waveguide switch path.

Figure 8-9: FPRC-1200 1:2 Phase Combined Redundant Controller

In normal operation, HPA 2 should be selected as the standby amplifier. HPA 2 is the middle amplifier on the amplifier frame. This allows HPA 1 and HPA 3 to be combined by the waveguide combiner. If HPA 1 or HPA 3 were to ever fail, HPA 2 can be switched in place of either HPA 1 or HPA 3 and the system will still maintain full output power capability over the full operating bandwidth of the amplifier. Figure 8-10 shows the FPRC-1200 with HPA 2 selected as the standby amplifier.

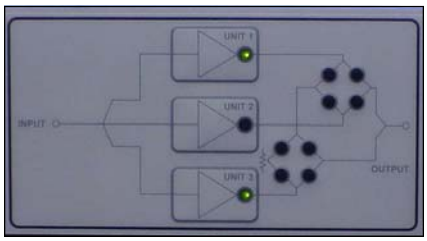

Figure 8-10:
HPA 1 & HPA 3 on line
with HPA 2 on standby

8.5.1 Output Power Adjustment

Each 1:2 Fixed Phase Combined SSPA System has been factory set for optimal Phase Combining before shipment and should not need adjustment during installation and operation. In the event that an amplifier is replaced, it may then be necessary to make additional phase adjustment.

The two phase adjusters are located inside the Signal Box and are labeled PA1 and PA2. To make adjustments, loosen the 7/16" locking nut at the bottom of the phase adjuster and connect a power meter or spectrum analyzer to the crossguide coupler at the output of the system after removing the detector and attenuator.

To adjust the phase combining, unmute all amplifiers and, using the FPRC-1200, set HPA 1 as the standby amplifier. With a CW signal applied to the input of the system, vary phase adjuster (PA2) to peak the power reading on the power meter or spectrum analyzer or the FPRC-1200 controller's output power display.

With HPA 2 and 3 power combined, phase adjuster (PA2) will be used to maximize the output power. Next, select HPA 2 as the standby. This combines HPA 1 and HPA 3. Use phase adjuster (PA1) to optimize power.

It may be necessary to repeat the steps above to verify the power with all HPA combinations. Choose the best compromise in power for all combinations so that if switch over on fault does occur there is no noticeable increase or decrease in output power.

After phase combining is complete use the locking nut on each phase adjuster to secure the adjustment knob so no accidental changes to the combining occur.

Before placing the system back in operation, replace the cover to the Signal Box.

Figure 8-11: 1:2 Fixed Phase Combined Compact Outdoor System

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9.0 Block Up Converter Overview

The Compact Outdoor SSPA is available with various L-Band up converter options. The primary up converter option is the Zero dBm Block Up Converter, ZBUC. ZBUC is offered in four C-Band configurations, two Ku-Band options, and one X-Band model. The ZBUC is not available in S-Band units. See Table 9-1 for specifications for the respective models. The ZBUC offers ultra low phase noise for applications where phase noise is an overriding factor.

The type of BUC housed within your Compact Outdoor SSPA is indicated by its model number, as shown in Figure 9-1. The example in Figure 9-1 shows a 140W C-Band Compact Outdoor SSPA with Internal Reference ZBUC. For a full description of this configurator, refer to the Compact Outdoor SSPA specification sheet (205485).

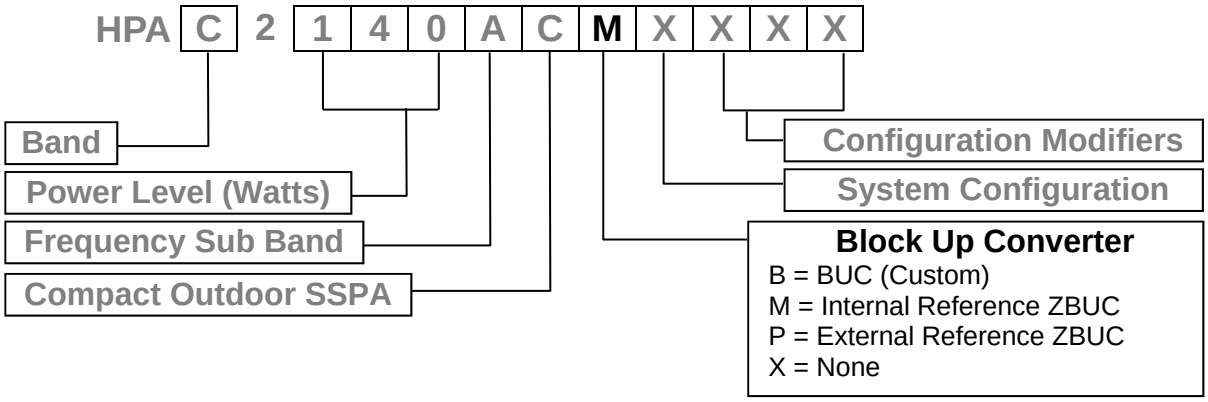

Figure 9-1: Configurator, Compact Outdoor SSPA, BUC Options

The block up converters are high performance frequency translation devices which provide excellent phase noise and spurious performance. The ZBUC also supports FSK communications for remote M&C capability. The FSK is a 650 KHz signal that is multiplexed onto the L-Band input of the unit.

The ZBUC utilizes Paradise Datacom's proprietary "Smart Reference Technology". Smart Reference Technology allows the system user to change reference frequency and power level or choose internal or external reference without requiring any system configuration. An internal BUC adds about 1.5 pounds to the overall weight of the Compact Outdoor unit.

The schematic of Figure 9-2 shows the electrical position of the block up converter. It is powered from a +15 VDC supply available on the Fan Boost Converter board assembly. The Block Up Converter is simply cascaded with the SSPA at the input of the amplifier.

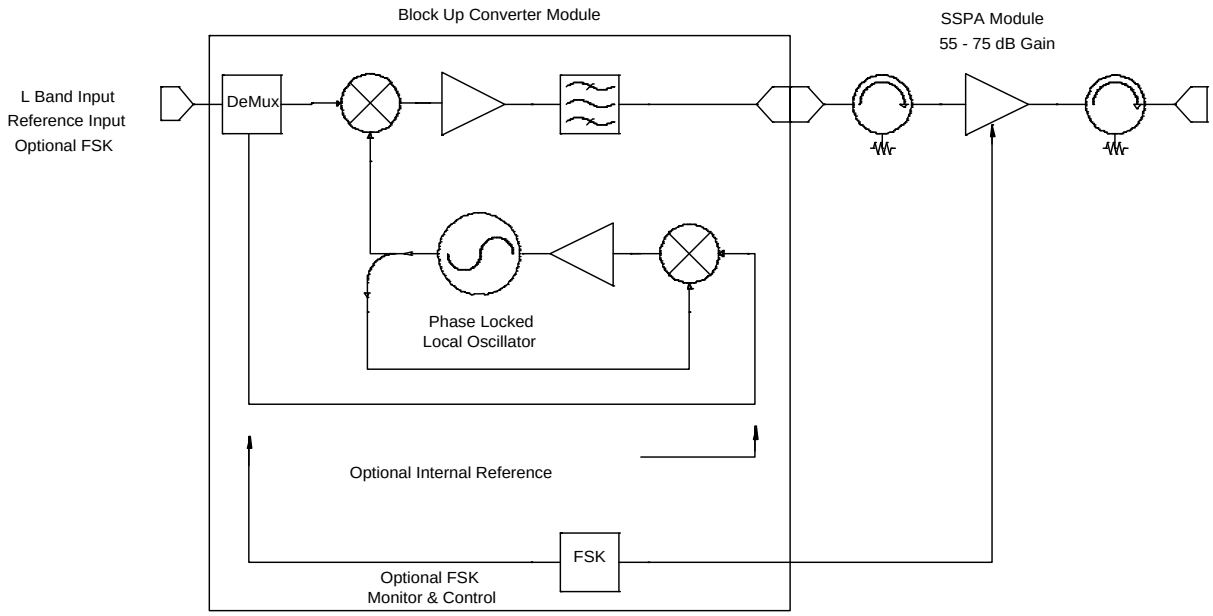

Figure 9-2: Compact Outdoor Block Diagram of BUC / SSPA System

It is important to remember the requirement of a 10 MHz reference oscillator when operating an SSPA with BUC (SSPB). If the 10 MHz reference is not present, the M&C will report a BUC alarm and the SSPA module will mute. This ensures that no spurious or 'off frequency' transmission could originate from the amplifier.

Note: Unless the BUC has the built-in internal reference option, if there is an absence of a 10 MHz reference signal on the IFL input there will be no output signal from the SSPA.

9.1 ZBUC Features

This section describes the features available in the Paradise Datacom ZBUC. The ZBUC is available as an option for the Compact Outdoor SSPA. ZBUC is available in four C-Band models, two Ku-Band models, one X-Band model and one Ka-Band model. Table 9-1 shows the specifications for the respective models.

Table 9-1: ZBUC Frequency Specifications

Band	Model Number*	IF Input	LO Frequency	RF Output	Gain Change
C	ZBUCCXXAXX1XX	950 - 1525 MHz	4.900 GHz	5.850 - 6.425 GHz	0 - 4 dB
C	ZBUCCXXBXX1XX	950 - 1825 MHz	4.900 GHz	5.850 - 6.725 GHz	0 - 4 dB
C	ZBUCCXXDXX1XX	950 - 1250 MHz	5.475 GHz	6.425 - 6.725 GHz	0 - 4 dB
C	ZBUCCXXEXX1XX	950 - 1250 MHz	5.775 GHz	6.725 - 7.025 GHz	0 - 4 dB
X	ZBUCXXXAXX1XX	950 - 1450 MHz	6.950 GHz	7.900 - 8.400 GHz	0 - 2 dB
Ku	ZBUCKXXAXX1XX	950 - 1450 MHz	13.050 GHz	14.00 - 14.50 GHz	0 - 2 dB
Ku	ZBUCKXXBXX1XX	950 - 1700 MHz	12.800 GHz	13.75 - 14.50 GHz	0 - 2 dB
Ka	ZBUCKAXAXX1XX	1000 - 2000 MHz	29.000 GHz	30.00 - 31.00 GHz	N/A

* Listed model numbers indicate an external reference.

9.2 ZBUC Theory of Operation

The ZBUC is a low gain block up converter with a P_{1dB} of 0dBm. This topology allows the system to be integrated with little impact on the general electrical specifications of the SSPA module.

The ZBUC utilizes single up conversion from L-Band to the desired RF band. The local oscillator circuits are designed to maintain the lowest possible output phase noise. The frequency synthesizer utilizes industry leading technology which allows for phase noise performance previously unattainable in PLL design. Typical phase noise specifications are outlined in Table 9-2.

Table 9-2: ZBUC RF output phase noise specification

Offset	Guaranteed Maximum	C-Band (Typical)	X-Band (Typical)	Ku-Band (Typical)	Ka-Band (Typical)	Units
10 Hz	-30	-60	-60	-50	-60	dBc/Hz
100 Hz	-60	-80	-75	-65	-72	dBc/Hz
1 KHz	-70	-80	-75	-72	-75	dBc/Hz
10 KHz	-80	-85	-100	-90	-88	dBc/Hz
100 KHz	-90	-120	-110	-110	-112	dBc/Hz
1 MHz	-90	-125	-122	-120	-122	dBc/Hz

Band selectivity is accomplished using the most aggressive filtering possible while maintaining specified power and spurious performance.

9.3 Smart Reference Technology

Paradise Datacom's new ZBUC comes standard with smart reference technology. Smart reference technology allows the system operator to change external system reference frequency without any system configuration required. The ZBUC will automatically sense and lock to any one of the following system reference frequencies: 5, 10, 20, 25, and 50 MHz. With the internal reference option installed the ZBUC will operate with no external reference applied. In the event the system operator wishes to operate on external reference, the ZBUC will automatically sense the presence of an external reference and switch to external reference mode. With the internal reference option installed, the internal reference also becomes a backup reference which will become active in the event that external system reference is lost.

External reference is applied to the ZBUC via the L-Band input IFL and is routed to the frequency synthesizer using the built-in demux circuitry.

Notes:

1) **The external reference option requires the system operator to provide system reference to the ZBUC/SSPB. The system will not lock and will have no output without external reference applied.**
2) **Internal reference option allows for either internal or external reference operation.**

The 10 MHz crystal reference used in the internal reference of the ZBUC™ has the following specifications:

Frequency Stability:	≤±1 • 10^{-8} over the temperature range -40 to +90 °C	
	≤±1 • 10^{-9} aging per day	
	≤±5 • 10^{-8} aging per year	
Warm up time:	20 minutes for better than ≤±1 • 10^{-8}	
Phase Noise:	10 Hz	-120 dBc/Hz
	100 Hz	-140 dBc/Hz
	1 KHz	-145 dBc/Hz
	10 KHz	-152 dBc/Hz
	100 KHz	-155 dBc/Hz
Frequency Accuracy:	Factory preset to ±1 • 10^{-8}	

9.4 ZBUC FSK Monitor and Control

With the ZBUC, FSK Monitor and control comes standard. This allows the Compact Outdoor SSPB to be fully and remotely monitored and controlled through the system's IFL. An embedded controller enables remote communication and fault detection via the IF input between the SSPA and a Paradise Datacom Evolution Series L-Band modem. This signal consists of a 650 KHz Frequency Shift Keyed carrier that is multiplexed onto the L-Band input IFL along with the 10 MHz reference signal. The monitor and control functionality is explained in detail in Section 10.

The FSK input has a center frequency of 650 KHz with a ±5% tolerance. The FSK deviation is ±60 KHz, with +60 KHz being a "mark" and -60 KHz being a "space". The FSK input will work over an input power range of -5 to -15 dBm. The FSK characteristics are summarized below:

Frequency	650 kHz ± 5%
FSK Deviation	± 60 kHz nominal (+60 kHz mark)
Deviation Tolerance	± 50 kHz minimum, ± 70 kHz maximum
Locking Range	± 32.5 kHz
Input Level Range	-5 to -15 dBm
Start Tone Time	10 ms minimum

See Paradise Datacom document number 201410 for a full description of the VSAT BUC Protocol.

9.5 Typical System Configuration

This section shows the Compact Outdoor SSPB in a common system application. Figure 9-3 shows the Compact Outdoor used with a Paradise Datacom Evolution Series PD25 modem.

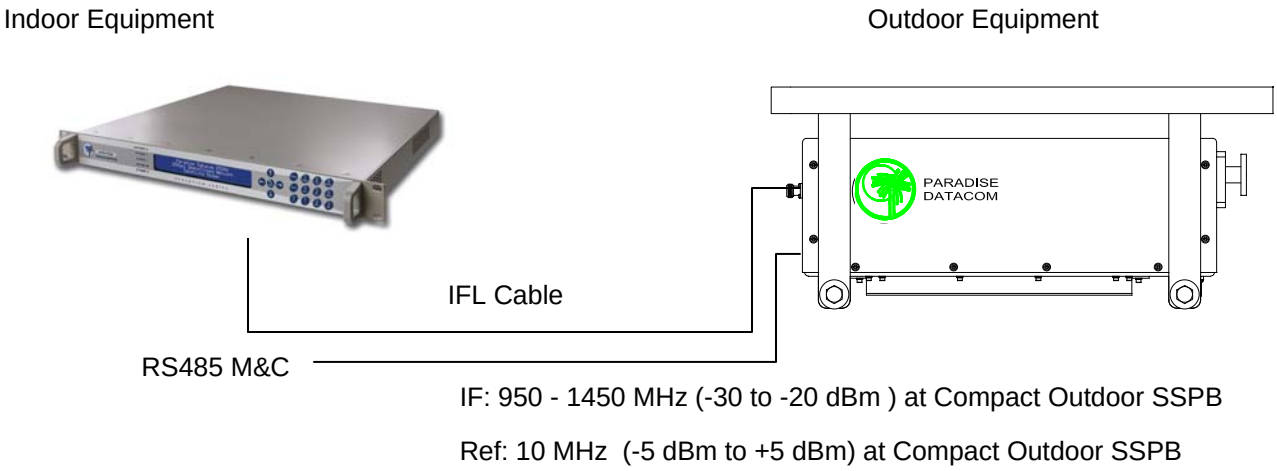
Indoor Equipment
Outdoor Equipment
PARADISE
DATACOM
IFL Cable
RS485 M&C
IF: 950 - 1450 MHz (-30 to -20 dBm) at Compact Outdoor SSPB
Ref: 10 MHz (-5 dBm to +5 dBm) at Compact Outdoor SSPB

Figure 9-3: Compact Outdoor SSPB with PD25 Evolution Modem

9.6 IFL Cable Considerations

Consideration should be given to using a high quality IFL between the indoor equipment and Compact Outdoor SSPB. The system designer must always consider the total cable loss for a given length and also the implications of the slope of attenuation across the 950 to 1450 MHz bandwidth. Table 9-3 gives the approximate attenuation vs. frequency for a variety of cable types.

Table 9-3: Common Coaxial Cable Characteristics

Cable Type	Center Conductor DC Resistance per 1000 ft.	Outer Diameter (inches)	Attenuation at 950 MHz dB per 100 ft.	Attenuation at 1450 MHz dB per 100 ft.	Slope across band for 100 ft. cable (dB)	Slope across band for 300 ft. cable (dB)
RG-214	1.7	.425	7.8	11.3	3.5	10.5
Belden 8214	1.2	.403	6.8	9.2	2.4	7.2
Belden 7733	.9	.355	5.8	8.3	2.5	7.5
Belden 9914	1.2	.403	4.5	6.3	1.8	5.4
Belden 9913	.9	.403	4.2	5.6	1.4	4.2

It is recommended to use a quality grade of 50 ohm cable such as Belden 9913, 9914, or 7733. Check the manufacturer's technical data to make sure that the insulation is sufficient for the particular installation including the cable's temperature range. Also make sure the coaxial connector from the IFL cable to the Compact Outdoor input is wrapped with a weather sealing tape to prevent water intrusion into the coaxial cable.

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10.0 Serial Communication Protocol

This section describes the basic serial communication protocol between the Compact Outdoor SSPA and a host computer. Serial port settings must be configured for 8 bit data at no parity, with 1 stop bit.

The Amplifier will only respond to properly formatted protocol packets. The basic communication packet is shown in Figure 10-1. It consists of a Header, Data, and Trailer sub-packet.

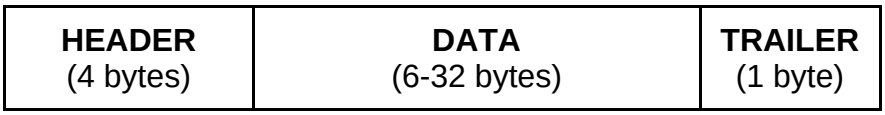


Figure 10-1: Basic Communication Packet

10.1 Header Packet

The Header packet is divided into 3 sub-packets which are the Frame Sync, Destination Address, and Source Address packets, as shown in Figure 10-2.

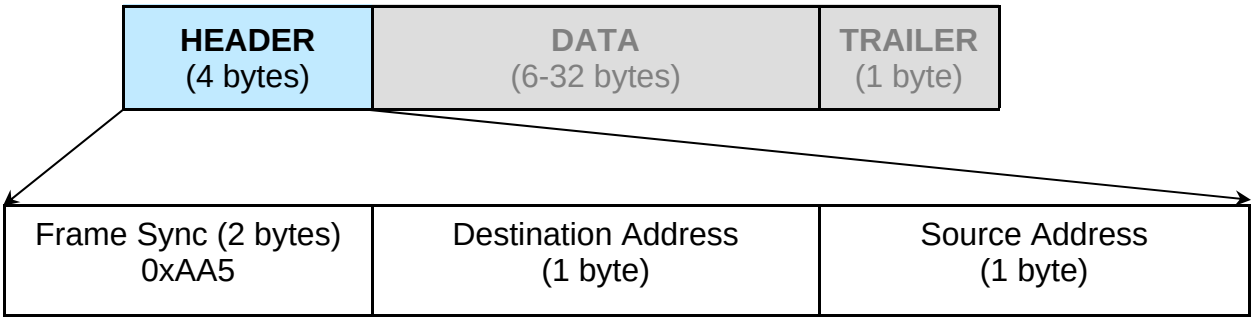


Figure 10-2: Header Sub-Packet

10.1.1 Frame Sync Word

The Frame Sync word is a two byte field that marks the beginning of a packet. This value is always 0xAA55. This field provides a means of designating a specific amplifier packet from others that may exist on the same network. It also provides a mechanism for a node to synchronize to a known point of transmission.

10.1.2 Destination Address

The destination address field specifies the node for which the packet is intended. It may be an individual or broadcast address. The broadcast address is 0xFF. This is used when a packet of information is intended for several nodes on the network. The broadcast address can be used in a single device connection when the host needs to determine the address of the amplifier. The Compact Outdoor amplifier will reply with its unique address.

10.1.3 Source Address

The source address specifies the address of the node that is sending the packet. All unique addresses, except the broadcast address, are equal and can be assigned to individual units. The host computer must also have a unique network address.

10.2 Data Packet

The data sub-packet is comprised of 6 to 32 bytes of information. It is further divided into 7 fields as shown in Figure 10-3. The first 6 fields comprise the command preamble while the last field is the actual data.

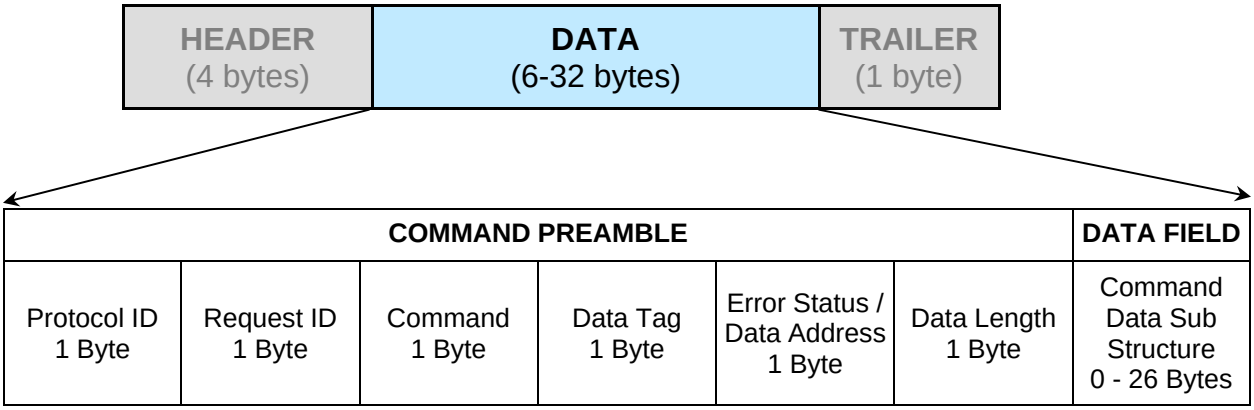


Figure 10-3: Data Sub-Packet

10.2.1 Protocol ID

This field provides backward compatibility with older generation equipment protocol. It should normally be set to zero. This field allows the amplifier to auto-detect other firmware versions.

10.2.2 Request ID

This is an application specific field. The amplifier will echo this byte back in the response frame without change. This byte serves as a request tracking feature.

10.2.3 Command

This one byte field tells the receiver how to use the attached data. There are only 4 possible values for this field. The sender and receiver are limited to two commands. For example: if the sender issued “Set Request” command, receiver must answer with “Set Response” command in his response frame. The same technique applies to the “Get Request” and “Get Response” form of the command. The byte value for each command is given in Table 10-1.

Table 10-1: Command Byte Values

Command Name	Command Byte Value
Set Request	0
Get Request	1
Set Response	2
Get Response	3

10.2.4 Data Tag

The data tag specifies the type of internal resource or information needed to be accessed on the Compact Outdoor Amplifier. The data associated with certain tags is read only. Therefore only the “Get” command byte would be associated with these data tags. The data tag byte values are given in Table 10-2.

Table 10-2: Data Tag Byte Values

Tag Name	Byte Value	Minimum valid length of Data Field	Description
System Tag Settings	0	1 byte	This tag allows accessing various system settings on remote unit. Host access status: Full Read/Write access. Settings can be modified at any time. Some settings may require hardware reset of the remote SSPA unit.
System Threshold Tag	1	2 bytes	This tag allows access to the critical unit thresholds. Host access status: Full Read/ Write access. New thresholds are in effect immediately after change.
System Conditions Tag	3	1 byte	This tag allows access to the unit’s internal conditions flags, such as fault status or current system status. Host access status: Read only. This type of data cannot be set or modified remotely.
ADC Channels Access Tag	4	2 bytes	This tag allows access to the unit’s internal Analog to Digital converter. Host access status: Read only. This type of data cannot be set or modified remotely.
Reserved	2	N/A	This tag is reserved and not used for SSPA applications.

10.2.5 Error Status / Data Address

This byte is a tag extension byte and specifies the first data element of the tagged data. If the Data Length is more then 1 byte, then all subsequent data fields must be accessed starting from the specified address. For example if the requestor wants to access the amplifier's unique network address, it should set data tag 0 (System settings tag) and data address 8 (see System Settings Details table). If the following Data Length field is more than 1, then all subsequent Settings will be accessed after the Unique Network Address. When the Response Frame Data Address is omitted, this byte position is replaced with the Error Status fields. The various error codes are given in Table 10-3. Note that the Request and Response frames are different.

Table 10-3: Error Status Byte Values

Error Code Name	Byte Value	Possible Cause
No Errors	0	Normal Condition, no errors detected
Data Frame Too Big	1	Specified Data length is too big for amplifier buffer to accept
No Such Data	2	Specified Data Address is out of bounds for this tag data
Bad Value	3	Specified value not suitable for this particular data type
Read Only	4	Originator tried to set a value which has read only status
Bad Checksum	5	Trailer checksum not matched to calculated checksum
Unrecognizable Error	6	Error presented in incoming framed, but SSPA failed to recognize it. All data aborted

10.2.6 Data Length

This byte contains different information for Request and Response frames. In a Request frame, it specifies the number of data bytes that are to be accessed starting from the first byte of the value specified in the Data Address byte. That byte must not exceed the maximum data bytes for a particular tag. The maximum data length for the Settings tag is 26 bytes. The maximum data length for the System Threshold tag is 6 bytes.

10.2.7 Data Field

The actual data contained in the packet must be placed in this field. The "Get Request" type of command must not contain any Data Field. Any "Get Request" will be rejected if any data is present in the Data Field. Generally, the Bad Checksum error code will be added to the response from the amplifier if the word size of the information is 16-bits or 2-bytes. Each data word is placed in the frame with its least significant byte first. All data with length of 2 bytes must be represented as integer type with maximum value range from 32767 to (-32767).

10.3 Trailer Packet

10.3.1 Frame Check

The trailer component contains only one (1) byte called the Frame Check Sequence, shown in Figure 10-7.

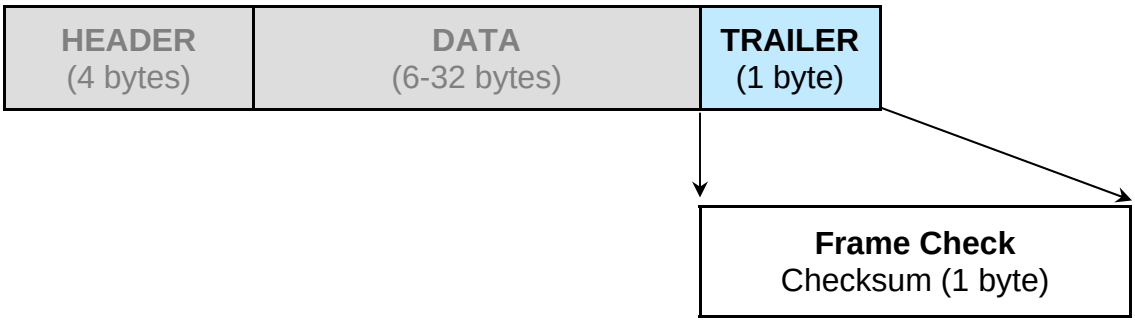


Figure 10-4: Trailer Sub-Packet

This field provides a checksum during packet transmission. This value is computed as a function of the content of the destination address, source address and all Command Data Substructure bytes. In general, the sender formats a message frame , calculates the check sequence, appends it to the frame, then transmits the packet. Upon receipt, the destination node recalculates the check sequence and compares it to the check sequence embedded in the frame. If the check sequences are the same, the data was transmitted without error. Otherwise an error has occurred and some form of recovery should take place. In this case the amplifier will return a packet with the “Bad Checksum” error code set. Checksums are generated by summing the value of each byte in the packet while ignoring any carry bits. A simple algorithm is given as:

```
Chksum=0
FOR byte_index=0 TO byte_index=packet_len-1
        Chksum=(chksum+BYTE[byte_index]) MOD 256
NEXT byte_index
```

10.4 Timing issues

There is no maximum specification on the inter-character spacing in messages. Bytes in messages to amplifier units may be spaced as far apart as you wish. The amplifier will respond as soon as it has collected enough bytes to determine the message. Generally, there will be no spacing between characters in replies generated by units. The maximum length of the packet sent to the amplifier node should not exceed 64 bytes, including checksum and frame sync bytes. Inter-message spacing, must be provided for good data transmission. The minimum spacing should be 100 ms. This time is required for the controller to detect a “Line Cleared” condition with half duplex communications. Maximum controller respond time is 200 ms.

Table 10-4: Request Frame Structure

Byte position	Byte Value (Hex)	Description
1	0xAA	Frame Sync 1
2	0x55	Frame Sync 2
3	Destination Address	-//-
4	Source Address	-//-
5	Protocol Version	Protocol compatibility hole, must be set to 0
6	Request ID	Service Byte
7	Command	0, Set Request; 1, Get Request
8	Data Tag	0, System Settings; 1, System Thresholds; 2, Temp. Sensor Settings; 3, Conditions; 4, ADC Data; 5, Raw NVRAM/RAM Data
9	Data Address	Setting number, Sensor command, EEPROM address
10	Data Length	Total length of the data, valid values 1-30
11+N	Data	Actual Data
11+N+1	Checksum	Dest. Address + Source Address + Protocol Version + Request ID + Command + Data Tag + Data Address + Data Length + Data

Table 10-5: Response Frame Structure

Byte position	Byte Value (Hex)	Description
1	0xAA	Frame Sync 1
2	0x55	Frame Sync 2
3	Destination Address	-//-
4	Source Address	-//-
5	Protocol Version	Protocol compatibility hole, must be set to 0
6	Request ID	Service Byte
7	Command	2, Set Response; 3, Get Response
8	Data Tag	0, System Settings; 1, System Thresholds; 2, Temp. Sensor Settings; 3, Conditions; 4, ADC Data; 5, Raw NVRAM/RAM Data
9	Error Status	0, No Errors; 1, Too Big; 2, No Such Data; 3, Bad Value; 4, Read Only; 5, Bad Checksum; 6, Unrecognized Error
10	Data Length	Total length of the data, valid values 1-30
11+N	Data	Actual Data
11+N+1	Checksum	Dest. Address + Source Address + Protocol Version + Request ID + Command + Data Tag + Data Address + Data Length + Data

Table 10-6: System Settings Data Values

Data Address	# Bytes	Description	Limits and Byte Values
1	1	System Operation Mode	Single Amplifier = 255; Dual 1:1 = 1 (version 3.60); 1:1 Redundant = 0
2	1	System Hierarchical Address	HPA 1= 0; HPA 2= 255
3	1	Unit Start Up State (in Redundancy)	Standby Amplifier = 0 On Line Amplifier = 1
4	1	Mute State	Mute Clear (Transmit Enable) = 255 Mute Set (Transmit Disable) = 0
5	1	Attenuation Level (dB down from maximum gain)	[1 bit for every 0.1 dB] 0 dB attenuation = 0 20 dB attenuation = 200
6	1	Module Gain Control Authority	Serial Port Gain Control = 255 External Analog Voltage Gain Control = 0
7	1	Amplifier Network Address	0 to 255
8	1	High Temperature Alarm Threshold	0 to 125 (in ^{o}C)
9	1	SSPA module Calibration Mode	Temperature Compensated = 255 (normal state) Calibration Mode = 0
10	1	SSPA Spare Fault Status	Ignore Spare Fault = 255 Fault on value of window on ADC channel = 0 to 7 Fault on External Mute = 8
11	1	SSPA Spare Fault Handling	Minor Fault (no effect on Summary Fault) = 255 Major Fault (Triggers Summary Fault) = 0 Major Fault with Mute (Transmit Disabled) = 1
12	1	SSPA Auxiliary Fault Status	Ignore Auxiliary Fault = 255 Fault on Logic Low State = 1 Fault on Logic High State = 0 Startup in Low Z State = 2 Startup in High Z State = 3 (version 3.50 - See SierraCom Protocol for details)
13	1	SSPA Auxiliary Fault Handling	Minor Fault (No effect on Summary) = 255 Major Fault (Triggers Summary Fault) = 0 Major Fault with Mute (Transmit Disabled) =1 Minor Fault with Mute = 2 (version 3.50)
14	1	Block Up Converter Fault Status	Ignore BUC Fault = 255 Fault on Logic Low State = 1 Fault on Logic High State = 0
15	1	Block Up Converter Fault Handling	Minor Fault (no effect on Summary Fault) = 255 Major Fault (Triggers Summary Fault) =0 Major Fault with Mute (Transmit Disabled) = 1
16	1	Protocol Select	Standard String Protocol = 255 Terminal Mode = 0 Binary Mode (compatible with CO SSPA serial numbers 100,001 - 199,999) = 1 SierraCom Protocol = 2 (version 3.50; compatible with SierraCom VSAT BUC and NDSat SkyWAN modem, see Appendix D for details)
17	1	Baud Rate Select	9600 = 255 38400 = 0 19200 = 1 4800 = 2 2400 = 3
18-19	2	Reserved	Reserved for Factory use.
20	1	Standby Mode	Hot standby=255; Cold standby=0 (version 3.50)
21	1	BUC Reference	Autoswitch = 0; External = 1; Internal = 2 (version 3.60)

Note: Data length must be at least two bytes to form integer with the lower byte sent first. If odd number of bytes is received, the last byte will be saved as the lower byte of the integer and upper part will be zero.

Table 10-7: System Condition Addressing

Data Address	# Bytes	Description	Limits and valid values
1	2	Present DAC value (Read Only in Temp Co Mode)	0 to 1023
2	2	Present Temperature	± 125
3	2	Fault, Mute, and State Conditions	2-Byte Value 0 fault clear; 1 fault set 0 mute clear; 1 mute set 0 standby state, 1 on line state **Lower Byte** Bit 0 = Summary Fault Bit 1 = High Temp Fault Bit 2 = Low DC Current Fault Bit 3 = Low DC Voltage Fault Bit 4 = External Mute Status Bit 5 = Internal Mute Status Bit 6 = Reserved, always 0 Bit 7 = Reserved, always 0 **High Byte** Bit 0 = Block Up Converter Fault Bit 1 = Spare Fault Bit 2 = Auxiliary Fault Bit 3 = EEprom Cal Table Fault Bit 4 = RF Switch Control 1 state Bit 5 = RF Switch Control 2 state Bit 6 = Reserved, always 0 Bit 7 = Unit On Line State
4	2	Present Attenuation Level	1bit per 0.1 dB attenuation Low Byte: 0 to 200 High Byte: always 0
5	2	Present RF Power Level Output is dBm x 10 ie 455 = 45.5 dBm	0 to 1023
6	2	SSPA DC Current	200 Amp maximum 1 value = 0.1 Amp
7	2	Regulator DC Voltage	15 Volt maximum 1 value = 0.1 Volt
8	2	Power Supply Voltage	15 Volt maximum 1 value = 0.1 Volt
9	2	Transistor Gate Voltage	0 to 10 volt range Use 2's compliment integer math 1 value = 0.1 Volt

Table 10-8: ADC (Analog-Digital Converter) Addressing

Data Address	# Bytes	Description	Limits and valid values
0	2	Current value of ADC channel 0	Reserved Value Range: 0 to 1023 Conversion: N/A
1	2	Current value of ADC channel 1	RF Power Detector #1 Reflected Value Range: 0 to 1023 Conversion: N/A
2	2	Current value of ADC channel 2	Analog Gain Adjust Voltage Value Range: 0 to 1023 Conversion: 1 value = 2.44mV
3	2	Current value of ADC channel 3	RF Power Detector #1 Forward Value Range: 0 to 1023 Conversion: N/A
4	2	Current value of ADC channel 4	Gate Voltage Value Range: 0 to 1023 Conversion: 1 value = -9.4mV
5	2	Current value of ADC channel 5	Regulator Voltage Value Range: 0 to 1023 Conversion: 1 value = 14.66 mV
6	2	Current value of ADC channel 6	Power Supply Voltage Value Range: 0 to 1023 Conversion: 1 value = 14.66 mV
7	2	Current value of ADC channel 7	SSPA Current Value Range: 0 to 1023 Conversion: 1 value = 97.75 mA

Table 10-9: System Threshold Data Values

Data Address	# Bytes	Description	Limits and valid values
1	2	Low Current Fault Threshold	Minimum value = 0 Maximum value = 1023
2	2	Spare Fault Window Lower Limit	Minimum value = 0 Maximum value = 1023
3	2	Spare Fault Window Upper Limit	Minimum value = 0 Maximum value = 1023

10.5 Examples

10.5.1 Example 1

Table 10-10 shows an example of a communication exchange between a PC and Compact Outdoor Amplifier.

- SSPA Network Address = 5
- Host Computer Network Address = 10
- Request ID = 0x6F

Table 10-10: Example 1 Host PC Request String

Byte Position	Byte Value (Hex)	Description
1	AA	Frame Sync Byte 1
2	55	Frame Sync Byte 2
3	5	Destination Address of RCP unit
4	A	Source address of Request originating PC Host
5	0	Protocol Version Compatibility Field must always be 0
6	6F	Request ID byte is set by originator, will be echoed back by respondent
7	1	Command field for “Get” type request
8	0	“SSPA Settings” tag indicates which data from respondent required in response frame
9	1	Data Address field indicates the beginning data address inside of the “SSPA Settings” data set to 1 (first element)
10	A	Data Length field indicates how many data bytes of the “SSPA Settings” requested from the amplifier
11	8A	Arithmetic checksum of bytes number 3 through 10

The Compact Outdoor Amplifier replies with the response string of Table 10-11.

Table 10-11. Example 1 SSPA Response String

Byte Position	Byte Value (Hex)	Description
1	AA	Frame Sync Byte 1
2	55	Frame Sync Byte 2
3	A	Destination Address of PC request originator
4	5	Source address of Responding Amplifier
5	0	Protocol Version Compatibility Field must always be 0
6	6F	Echo of the Originator's Request ID byte
7	3	Command field for "Get" type response
8	0	"SSPA Settings" tag indicates which data from respondent included in response frame.
9	0	Data Address field omitted and replaced with Error status code. 0 in this field indicates absence of errors.
10	A	Data Length field indicates how many data bytes of the "SSPA Settings" requested from the SSPA (12 is all available data of "System Conditions" type).
11	0	Data field 1 contains data element 1 of "System Conditions" data type
12	255	Data field 2 contains data element 2 of "System Conditions" data type
13	1	Data field 3 contains data element 3 of "System Conditions" data type
14	255	Data field 4 contains data element 4 of "System Conditions" data type
15	0	Data field 5 contains data element 5 of "System Conditions" data type
16	255	Data field 6 contains data element 6 of "System Conditions" data type
17	5	Data field 7 contains data element 7 of "System Conditions" data type
18	50	Data field 8 contains data element 8 of "System Conditions" data type
19	0	Data field 9 contains data element 9 of "System Conditions" data type
20	3	Data field 10 contains data element 10 of "System Conditions" data type
21	8F	Arithmetic checksum of bytes 3 through 20

10.5.2 Example 2

Change SSPA Attenuation to 20 dB (55dB gain)

- SSPA Network Address = 5
- Host Computer Network Address = 10
- Request ID = 0x6F

Table 10-12: Example 2 PC Request String

Byte Position	Byte Value (hex)	Description
1	AA	Frame Sync Byte 1
2	55	Frame Sync Byte 2
3	5	Destination Address of the unit
4	A	Source address of Request originating PC Host
5	0	Protocol Version Compatibility Field must be always 0
6	6F	Request ID is 111
7	0	Command “Set request” designator
8	0	Data tag “0” indicates access to SSPA Settings
9	5	Data address 5 indicates access to SSPA attenuation
10	1	Data length is 1 byte
11	C8	Data 200 - 20.0 dB x 10 attenuation
12	4C	Arithmetic checksum of bytes 3 to 11

Table 10-13. Example 2 SSPA Response String

Byte Position	Byte Value (hex)	Description
1	AA	Frame Sync Byte 1
2	55	Frame Sync Byte 2
3	A	Destination Address of PC request originator
4	5	Source address of the respondent
5	0	Protocol Version Compatibility Field must be always 0
6	6F	Echo of the Originator’s Request ID byte
7	2	“Set Response” designator
8	0	Data Tag “0” was accessed
9	0	Data address omitted and replaced with error status “0” – no errors.
10	1	Data length is 1 byte
11	C8	Data 200 - 20.0 dB x 10 attenuation successfully set
12	49	Arithmetic checksum of bytes 3 to 11

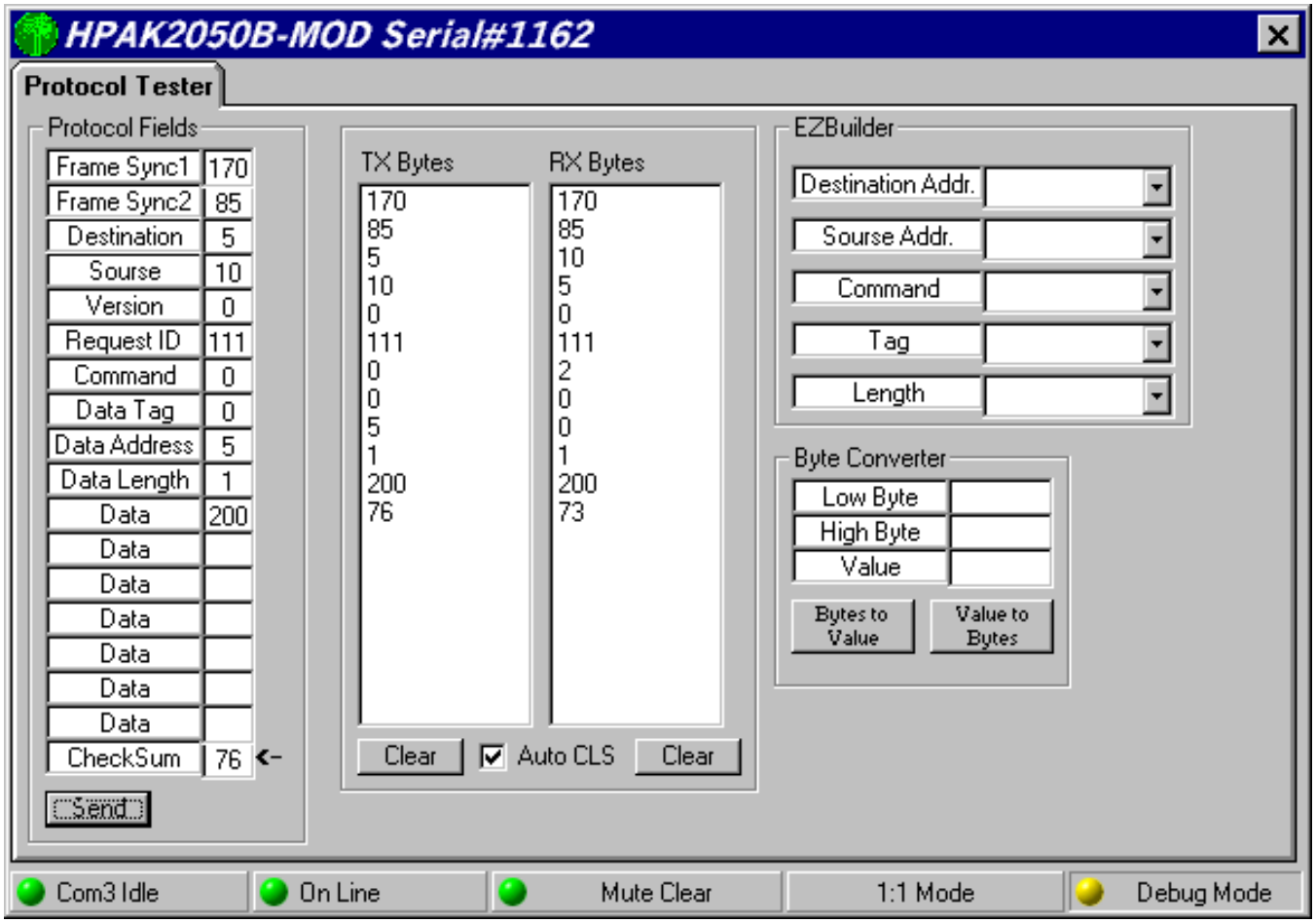


Figure 10-5: Example 2 Protocol Debugger Window in M&C Software. Note Byte values given in decimal representation.

10.5.3 Example 3

Check SSPA Faults and Condition Status

- SSPA Network Address = 5
- Host Computer Network Address = 10
- Request ID = 0x6F

Table 10-14. Example 3 PC Request String

Byte Position	Bytes Value (hex)	Description
1	AA	Frame Sync Byte 1
2	55	Frame Sync Byte 2
3	5	Destination Address of the unit
4	A	Source address of Request originating PC Host
5	0	Protocol Version Compatibility Field must be always 0
6	6F	Request ID is 111
7	1	“Get Request” designator
8	3	Data tag “3” – System Conditions
9	1	Data address 1 Beginning of the System Conditions table
10	12	18 Bytes – entire length of the system conditions table (2 bytes per value)
11	95	Arithmetic checksum of bytes 3 to 10

Table 10-15. SSPA Fault Status bit by bit description

Byte Value	Bit Count	Bit Value	Description
0 (Low Byte)	0	0	Summary Fault=0; Not Present
	1	0	High Temperature Fault=0; Not Present
	2	0	Low DC Current Fault=0; Not Present
	3	0	Low DC Voltage Fault=0; Not Present
	4	0	External Mute Status=0; Unmute
	5	0	Internal Mute Status=0; Unmute
	6	0	Reserved bit=0
	7	0	Reserved bit=0
128 (High Byte)	0	0	BUC Fault=0; Not Present
	1	0	Spare Fault=0; Not Present
	2	0	Aux. Fault=0; Not Present
	3	0	EEPROM Cal. Table Fault=0; Not Present
	4	0	RF Switch 1 Fault=0; Not Present
	5	0	RF Switch 2 Fault=0
	6	1	On Line State=1; Unit Online
	7	0	Reserved bit=0

Table 10-16. Example 3 SSPA Response String

Byte Position	Byte Value (hex)	Description
1	AA	Frame Sync Byte 1
2	55	Frame Sync Byte 2
3	A	Destination Address of PC request originator
4	5	Source address of the respondent
5	0	Protocol Version Compatibility Field must be always 0
6	6F	Echo of the Originator's Request ID byte
7	3	"Get Response" designator
8	3	Data Tag 3. System conditions access
9	0	Error status "0", No Errors
10	12	Data length - 18 bytes
11	47	Tempcomp attenuator DAC value Low Byte
12	2	Tempcomp attenuator DAC value High Byte, DAC Value=583
13	1C	SSPA internal core temperature Low Byte
14	0	SSPA internal core temperature High Byte, Temperature=28 C
15	0	SSPA Fault status Low Byte. See Table 10-15.
16	80	SSPA Fault status High Byte. See Table 10-15.
17	C8	SSPA Attenuation Level Low Byte
18	0	SSPA Attenuation Level, High Byte, Atten. Level=200 – 20.0 dB
19	82	Forward RF output Low byte
20	1	Forward RF output High byte, Forward RF=386 – 38.6 dBm
21	B6	SSPA DC Current Low Byte
22	2	SSPA DC Current High Byte, Current=694 – 69.4 Amps
23	67	SSPA Regulator DC voltage Low Byte
24	0	SSPA Regulator DC voltage High Byte, Voltage=103 – 10.3 Volts
25	95	SSPA Power Supply voltage Low Byte
26	0	SSPA Power Supply voltage High Byte, Voltage=149 – 14.9 Volts
27	D3	SSPA Gate Drive Voltage Low Byte
28	FF	SSPA Gate Drive Voltage High Byte Voltage= -45 – (-4.5) Volts
29	4C	Arithmetic checksum of bytes 3 to 28

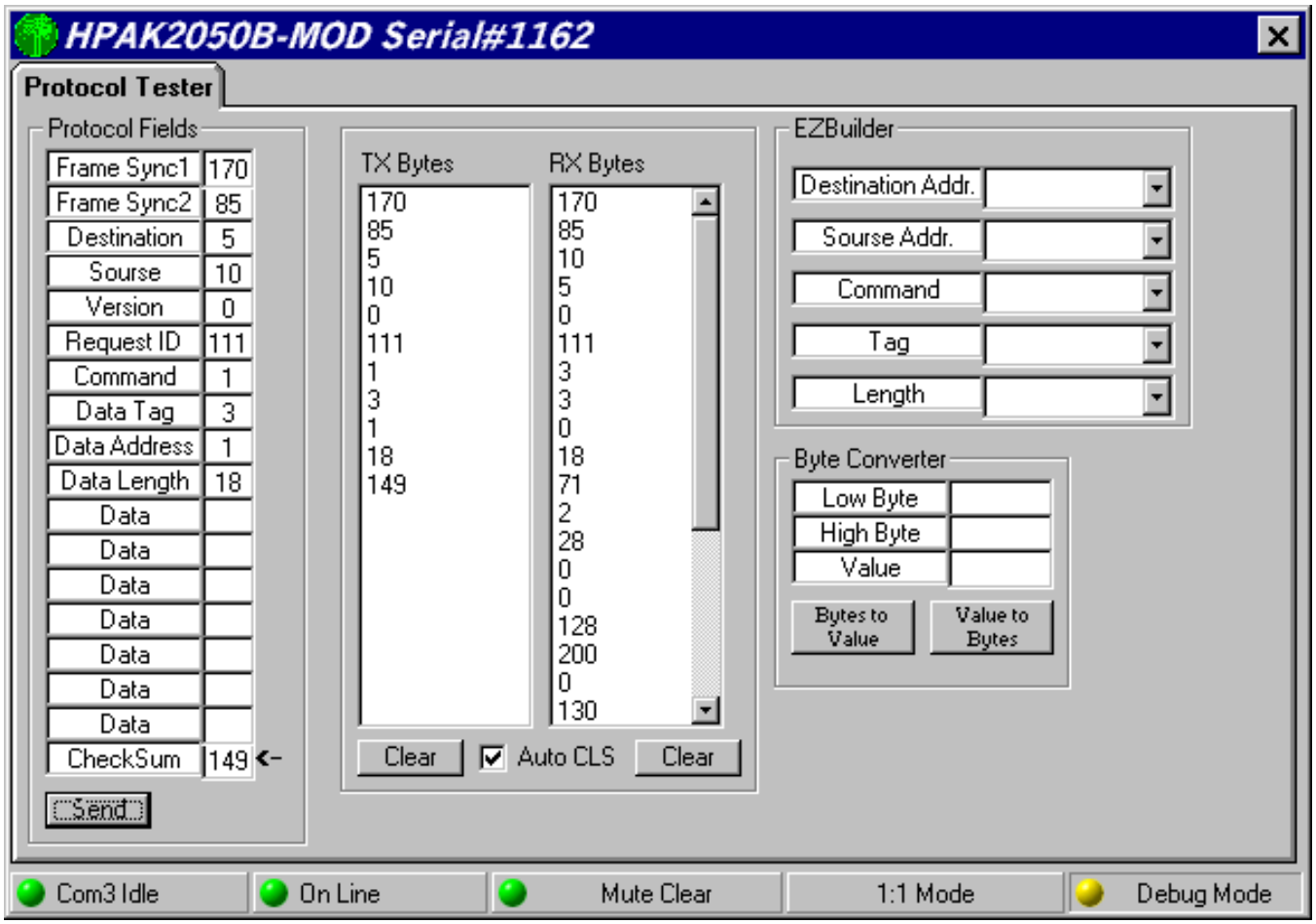


Figure 10-6: Example 3 Protocol Debugger Window in M&C Software. Note Byte values given in decimal representation.

11.0 Remote Operation

The Paradise Datacom Compact Outdoor SSPA utilizes Terminal Mode Serial Protocol (TMSP) as a secondary serial protocol for Management and Control through a Remote Serial Interface. TMSP allows the user to access internal SSPA functions via a remote ASCII Terminal or its equivalent (such as HyperTerminal for Windows). TMSP is accomplished through either the RS-232 or RS-485, half duplex, serial communication link.

U.S. ASCII encoded character strings are used to represent commands and data messages. A remote terminal or controller initiates a communication session and the SSPA takes action and returns a report of requested status. The SSPA will not initiate communication and will transmit data only when commanded to do so. Prior to establishing a session with a SSPA, this mode must be enabled through the front panel menu.

The remote terminal must be configured with serial settings that match the SSPA's serial port settings. For example, if the SSPA is set at 9600 Baud, the remote terminal must be also configured as ASCII terminal at 9600 Baud, no parity, 8 bit data with 1 stop bit serial connection. The SSPA will not echo back any incoming characters, so local echo must be enabled on the remote terminal.

To establish a remote control session with the SSPA terminal, the user must type **UNIT#XXX** in the terminal window, where XXX is the SSPA unique network address or the global call address (255). Press "Enter" on the Remote Terminal keyboard.

The Compact Outdoor should answer with **Unit#XXX OnLine** and display the first menu screen on the following lines. After a remote session is successfully established, the unit will remain connected as long as needed.

The session is organized in as menu selection with active keys. To help the user navigate through the menu, a help string with the list of active keys always follows the menu strings. For example:

"Active Keys(U)p+Enter; (D)own+Enter;(C)learFlt; (M)enu+Enter; (E)nd+Enter"

will be the last transmission string on all informative menu screens.

> **Note**: All letters must be in upper case!

To refresh the screen on the remote terminal, simply press the "Enter" key. To end a session with the Compact Outdoor SSPA, press the "E" and then "Enter" keys.

> **Important!** If multiple SSPA units are networked on the same serial link, do not establish a session with more than one SSPA at a time. If you do so, you will not get a valid response from the SSPA.

11.1 Menu Structure

All Compact Outdoor TMSP menus are organized in logical sublevels: Informative and Main Menu Selection.

At the beginning of the session, the SSPA will prompt the user with the first menu of the Informative sublevel. The user can access the Main menu from any informative sublevel by sequentially selecting the “M” and “Enter” keys on the remote terminal keyboard.

Figure 11-1 shows the Main menu structure hierarchy. There are five main levels of the menu selection:

1. Sys. Info – Shortcut to the Informative menu sublevel;
2. Com.Setup – Serial communication related settings;
3. Operation – SSPA operation related settings;
4. Fault Monitoring Setup – Fault handling settings;
5. Options –Optional settings.

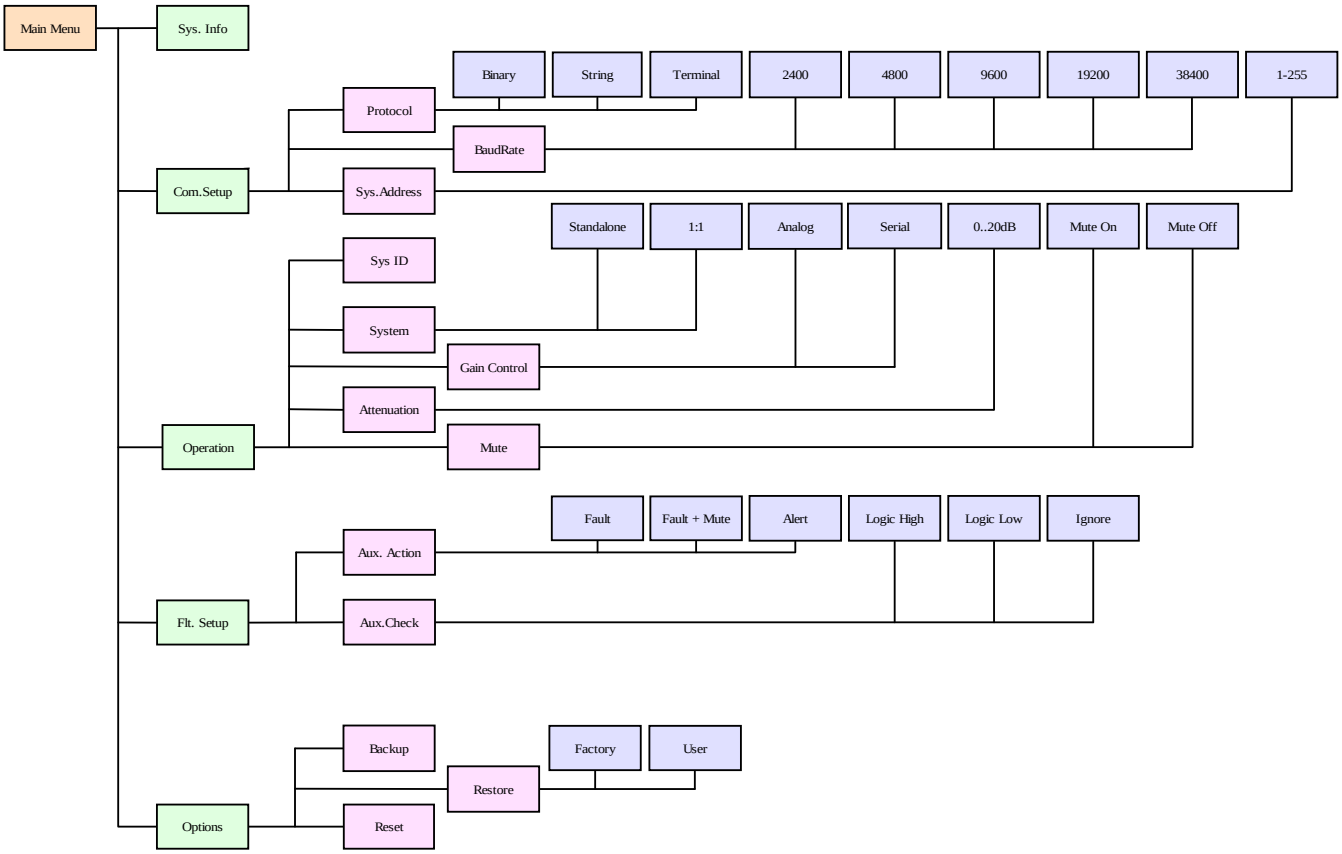


Figure 11-1: Main Menu Structure

11.1.1 System Information sub-menu

The informative sublevel of the menu structure contains five (5) pages, as shown in Figure 11-2.

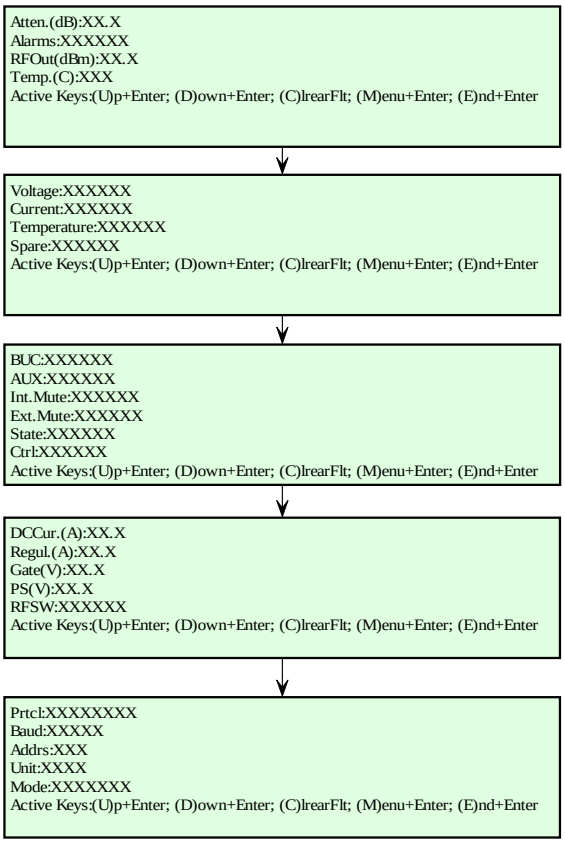


Figure 11-2: System Information menu structure

11.1.1.1 Sys Info Page 1

The page shows:

- The SSPA current level of attenuation, measured in dB (Atten.(dB):XX.X) with accuracy of 0.1 dB;
- Alarm presence, “FAULT!” or “None” will be displayed depending on the state of the SSPA;
- Forward RF Power in dBm with accuracy of 0.1 dBm;
- Current base plate temperature, measured in Centigrade.

11.1.1.2 Sys Info Page 2

The page shows a variety of alarm states which may be present within the SSPA. Fault values are “Fault” or “Normal”.

- Voltage – RF Module voltage regulator low voltage fault;
- Current – Low DC current fault;
- Temperature – high temperature fault;
- Spare – spare fault can reflect various fault conditions and events.

11.1.1.3 Sys Info Page 3

This page reflects various SSPA faults and conditions.

- BUC – Displays the block upconverter (BUC) fault (if equipped). Values “Fault” or “Normal”;
- Aux – Displays the auxiliary fault condition. Values – “Fault” or “Normal”;
- Int.Mute – Displays the internal mute condition (mute state controlled by internal SSPA hardware, such as serial protocol command or automatic over temperature shutdown). Values – “Off” or “On”;
- Ext.Mute – Displays the external mute condition (Mute condition controlled by hardware jumper on M&C connector). Values – “On” or “Off”;
- State – Displays the SSPA online state in a redundant system. Value – “Standby” or “Online”;
- Ctrl – Displays the type of attenuation control. Values – “Analog” or “Serial”.

11.1.1.4 Sys Info Page 4

This page shows the detailed information about the state of the SSPA‘s internal power supply characteristics, as well as the state of external wave-guide RF switch (if equipped).

- DCCur.(A) – The total DC current draw by the RF module from the main power supply with an accuracy of 0.1A. This value varies depending on the power level of SSPA. If the SSPA is in the mute state, the current drops to a 0 to 5A range.
- Regul.(V) – Displays the measured value of the internal RF module voltage regulator. The value in normal mode should be range from 8 to 10.5V. During SSPA mute period, this value drops to near 0V. Measurement is accurate to within 0.1V.
- Gate (V) – This value represents the negative GaAsFETs gate drive voltage. Normal value range is 1 to 6 V. The value reading may be affected by SSPA temperature changes and mute state.
- PS (V) – Displays the internal power supply voltage output. Normal range is 11 to 13 V, with an accuracy to within 0.1V.
- RFSW – Displays the state of the external wave-guide RF switch. This reading is valid only when the SSPA configured for internal 1:1 redundancy mode. Possible states are “Fault” or “Normal”.

11.1.1.5 Sys Info Page 5

This page displays the SSPA serial communication and redundancy related settings.

- Prtcl. – Displays the type of default implemented serial protocol. Values: Binary, String or Terminal.
- Baud – Displays the default SSPA baud rate. Values: 2400, 4800, 9600, 19200, 38400.
- Addrs – Displays the SSPA serial network address. Values: 0 to 255.
- Unit – Displays the SSPA 1:1 redundancy topological factor. Values: “HPA1” or “HPA2”.
- Mode – Displays the implemented redundancy mode. Values: “Standalone” or “1:1”.

11.1.1.6 Communication Setup sub menu

This menu allows the user to select the parameters for communication between the SSPA and the remote monitor and control station. All changes made on this menu will take effect only after a hardware reset of the SSPA controller card. This can be accomplished by either cycling the SSPA AC power or selecting the menu item from Terminal mode “Options” 7 “Reset” menu item.

Protocol
This selection allows the user to change the SSPA default serial protocol setting. “Binary” protocol will force the SSPA to use the protocol version compatible with earlier Compact Outdoor SSPAs (those with a serial number below 100 000). “String” is the default protocol for the current version of the Compact Outdoor SSPA. “Terminal” allows supporting TMSP.

Baud Rate
This item allows the user to select the desired baud rate for serial communication. Available baud rates include 2400, 4800, 9600, 19200 and 38400 Baud. The factory default baud rate is 9600.

System Address
This selection allows the user to set the network address of the controller if used on a RS-485 network. Choose from 1 to 255. The address 170 shouldn’t be selected, because it is reserved for global calls.

11.1.1.7 Operation setup sub menu

This menu allows user to select system-specific options.

SysID
Displays the unique SSPA ID tag as well as the firmware version of the controller card.

System
Allows the user to select the SSPA redundancy mode. Choose Standalone or 1:1.

Gain Control
Selects the style of SSPA attenuation control. User may select between “Analog” and “Serial” types of control.

Attenuation
Allows the user to set the SSPA attenuation level between 0 and 20 dB in steps of 0.1dB. In order to take effect, the SSPA must be configured for “Serial” type of attenuation control.

Mute
Selects the SSPA mute state. Selection values: “On” or “Off”.

11.1.1.8 Fault Setup sub menu

This menu allows the user to customize Auxiliary fault setup.

Aux. Action
Allows the selection of the final effect of the auxiliary fault on an SSPA operation. Selection: Fault (Major Fault), Fault + Mute, Alert (Minor Fault).

Aux. Check
Allows the user to select the fault-triggering event. Logic High – fault occurs on “open” unconnected state of auxiliary input line. Logic Low – fault occurs on “close” shorted to ground state of the auxiliary input line. Ignore – allows user to disable auxiliary fault checking.

Options menu

This menu makes available functions to backup or restore settings.

Backup
Allows the user to create a backup of all settings to nonvolatile memory.

Restore
Restores saved settings, either those from a previous backup (User), or to those as shipped from the factory (Factory).

Reset
Allows the user to remotely reset the SSPA controller card MCU, to allow the SSPA to apply new communication settings. The aftermath of the action depends on the selection which been made prior reset. If the SSPA is in Terminal mode protocol, communication with the unit may be reestablished after 5 seconds from the reset time. If the SSPA is configured to be a part of a 1:1 redundant system, the reset will cause the SSPA to go offline.

11.2 Configuring SSPA and PC to work with terminal mode protocol

Each unit is shipped from the factory with “String” type of protocol selected as the default serial protocol. To switch the SSPA to work with Terminal mode protocol, the user must use the supplied M&C utility software and establish a connection with the SSPA (see Compact Outdoor Amplifier Quick Start Guide for details).

1. Establish connection with the SSPA by using Paradise Datacom Quick Start Cable and PC’s RS232 serial port.
2. Start and configure Paradise Datacom Universal M&C utility. Make sure the M&C software has steady connection with the SSPA (green light at upper left corner of Status screen).
3. On the “Settings” tab, select the “Serial Protocol” setting as shown on Figure 11-3.

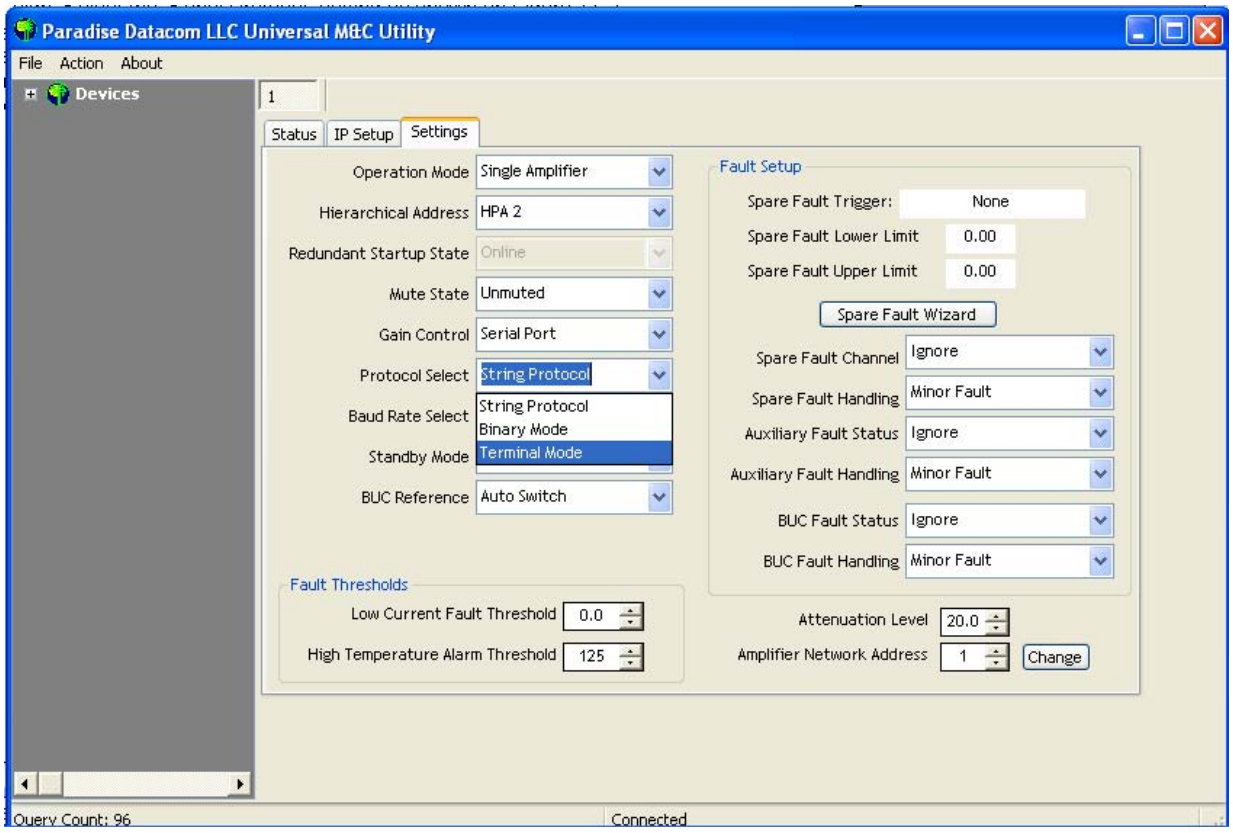


Figure 11-3: Universal M&C Settings Screen, Modifying Protocol Select

4. Select “Terminal’ in selection box. A dialog window will appear prompting you to accept the change in protocol See Figure 11-4.

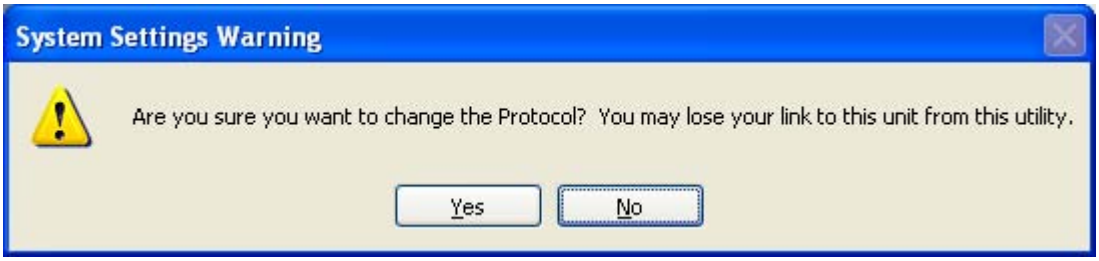

System Settings Warning
Are you sure you want to change the Protocol? You may lose your link to this unit from this utility.
Yes
No

Figure 11-4: Verification to Change Protocol

5. Cycle power to the unit. The unit is now configured to use Terminal mode serial protocol.

11.2.1 Remote Terminal Set-up

The following procedure will guide the user through the setup of a remote terminal, using Windows 95/98 HyperTerminal software. Prior to configuring the PC configurations, the SSPA must be connected to the PC COM port and configured to use TMSP at 9600 Baud.

1. Start the Windows HyperTerminal Program (default Windows location at Programs 7 Accessories 7 HyperTerminal).
2. At the prompted window, type the name of your serial connection ("Compact Outdoor SSPA" for example), and then click "OK." See Figure 11-5.

Figure 11-5: Connection Description window

3. Select a direct connection to the PC communication port (Com1 for example), to communicate with the SSPA, and then click "OK.". See Figure 11-6.

Figure 11-6: Connect To window

4. On the next dialog window, choose the following settings: Bits per Second – 9600; Data bits – 8; Parity – None; Stop bits – 1; Flow control – none. Then click “OK.” See Figure 11-7.

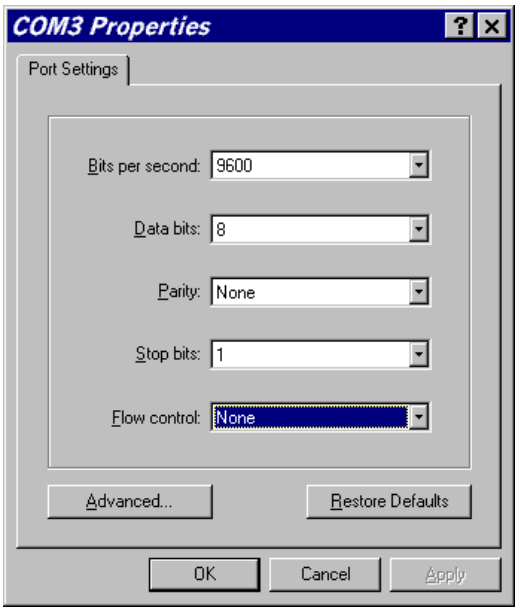
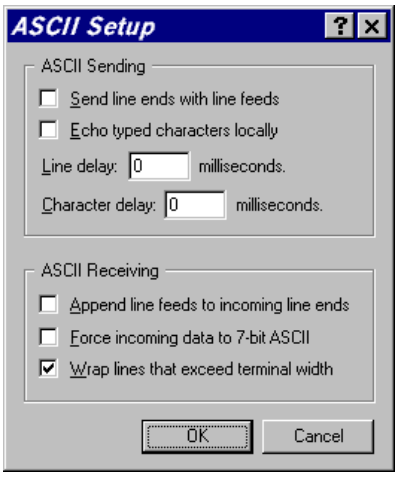


Figure 11-7: COM Properties window

5. The SSPA will not normally echo back characters typed by the user in the Terminal window. For added security and convenience, it is recommended to turn on Local Echo on HyperTerminal itself. To do so, from the HyperTerminal top menu select as followed: File 7 Properties 7 Settings 7 ASCII setup. The resulting window is shown on Figure 11-8. Check the box marked “Echo typed characters locally” and click “OK.” Due to a software bug on some Windows versions this feature does not properly work even when checked. To fix the bug, download the latest version of HyperTerminal (http://www.hilgraeve.com). Do not use a version of Hyperterminal earlier than 6.3.



Your PC is now configured to communicate with the Compact Outdoor SSPA in Terminal mode. To establish a session with SSPA, type **UNIT#170**.

Note: On a RS485 network, avoid using the global address (170). Instead, use the unique SSPA address.

An example of the terminal mode session shown on Figure 11-9.

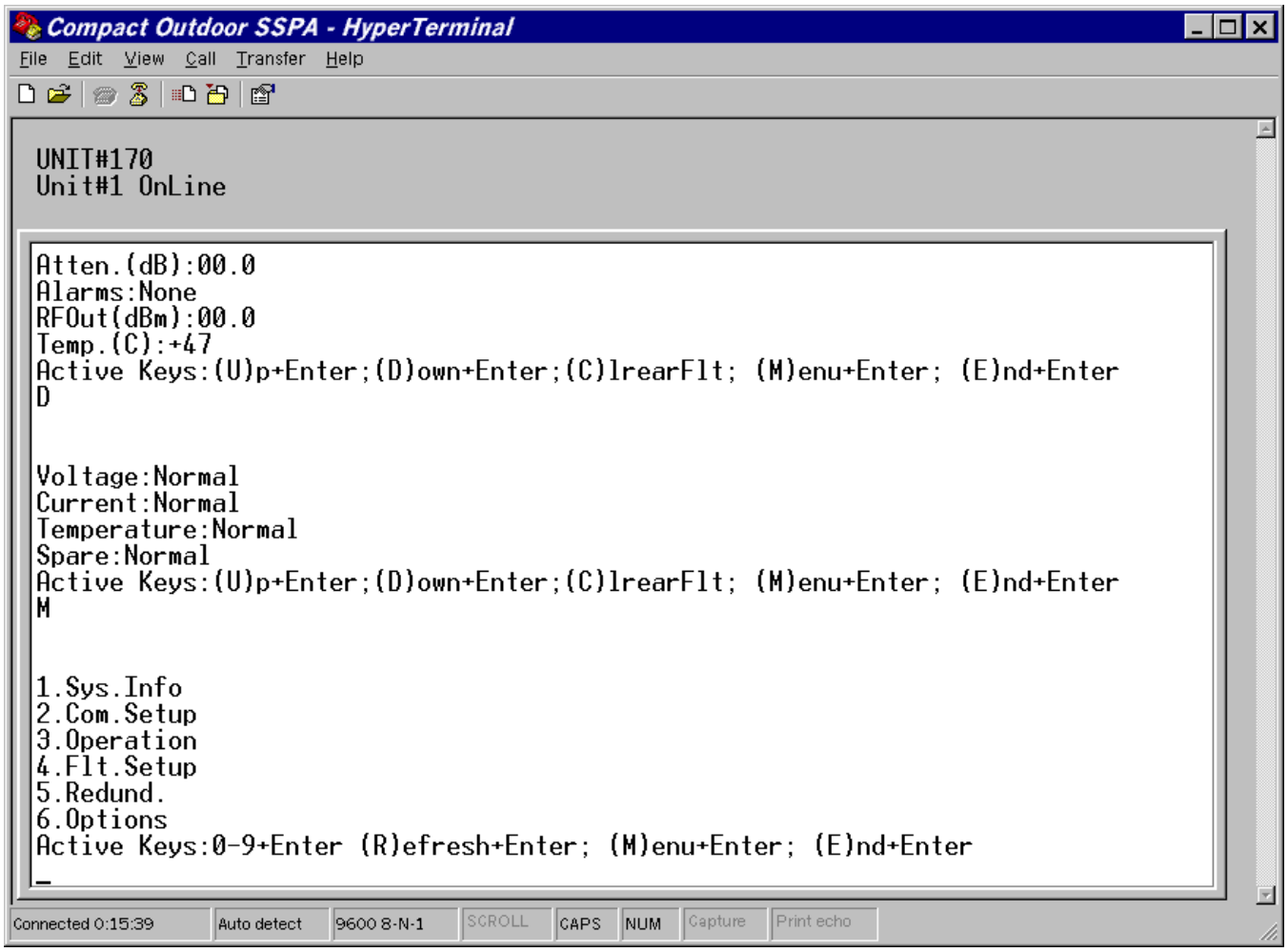


Figure 11-9: Example of Terminal Mode session

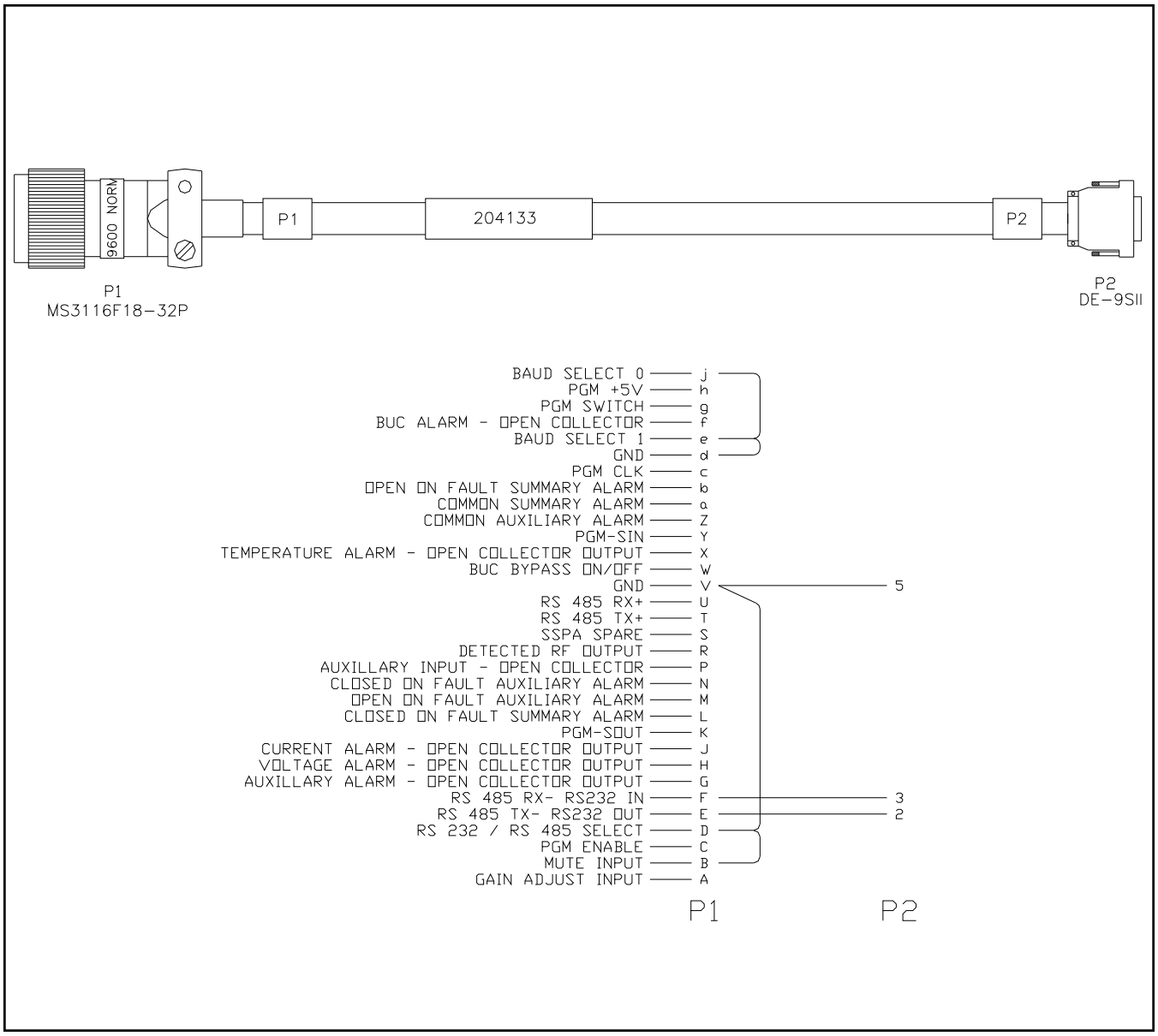

9600 NORM
P1
204133
P2
P1
MS3116F18-32P
P2
DE-9SII
BAUD SELECT 0 — j
PGM +5V — h
PGM SWITCH — g
BUC ALARM - OPEN COLLECTOR — f
BAUD SELECT 1 — e
GND — d
PGM CLK — c
OPEN ON FAULT SUMMARY ALARM — b
COMMON SUMMARY ALARM — a
COMMON AUXILIARY ALARM — Z
PGM-SIN — Y
TEMPERATURE ALARM - OPEN COLLECTOR OUTPUT — X
BUC BYPASS ON/OFF — W
GND — V — 5
RS 485 RX+ — U
RS 485 TX+ — T
SSPA SPARE — S
DETECTED RF OUTPUT — R
AUXILLARY INPUT - OPEN COLLECTOR — P
CLOSED ON FAULT AUXILIARY ALARM — N
OPEN ON FAULT AUXILIARY ALARM — M
CLOSED ON FAULT SUMMARY ALARM — L
PGM-SOUT — K
CURRENT ALARM - OPEN COLLECTOR OUTPUT — J
VOLTAGE ALARM - OPEN COLLECTOR OUTPUT — H
AUXILLARY ALARM - OPEN COLLECTOR OUTPUT — G
RS 485 RX- RS232 IN — F — 3
RS 485 TX- RS232 OUT — E — 2
RS 232 / RS 485 SELECT — D
PGM ENABLE — C
MUTE INPUT — B
GAIN ADJUST INPUT — A
P1
P2

Figure A-1. Quick Start Cable Schematic

“Quick-Start” Cable

Connects between Compact Outdoor Amplifier M&C port ,J4, and Computer COM Port.

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Mixing New Generation Compact Outdoor Amplifiers with Units Manufactured Prior to 2003

Configuring redundant systems with older model Compact Outdoor amplifiers with new generation models will require a different switch cable configuration than those shown in Section 7. Older generation amplifiers are generally those manufactured prior to year 2003. This switch cable can be ordered from the factory as part number 201608.

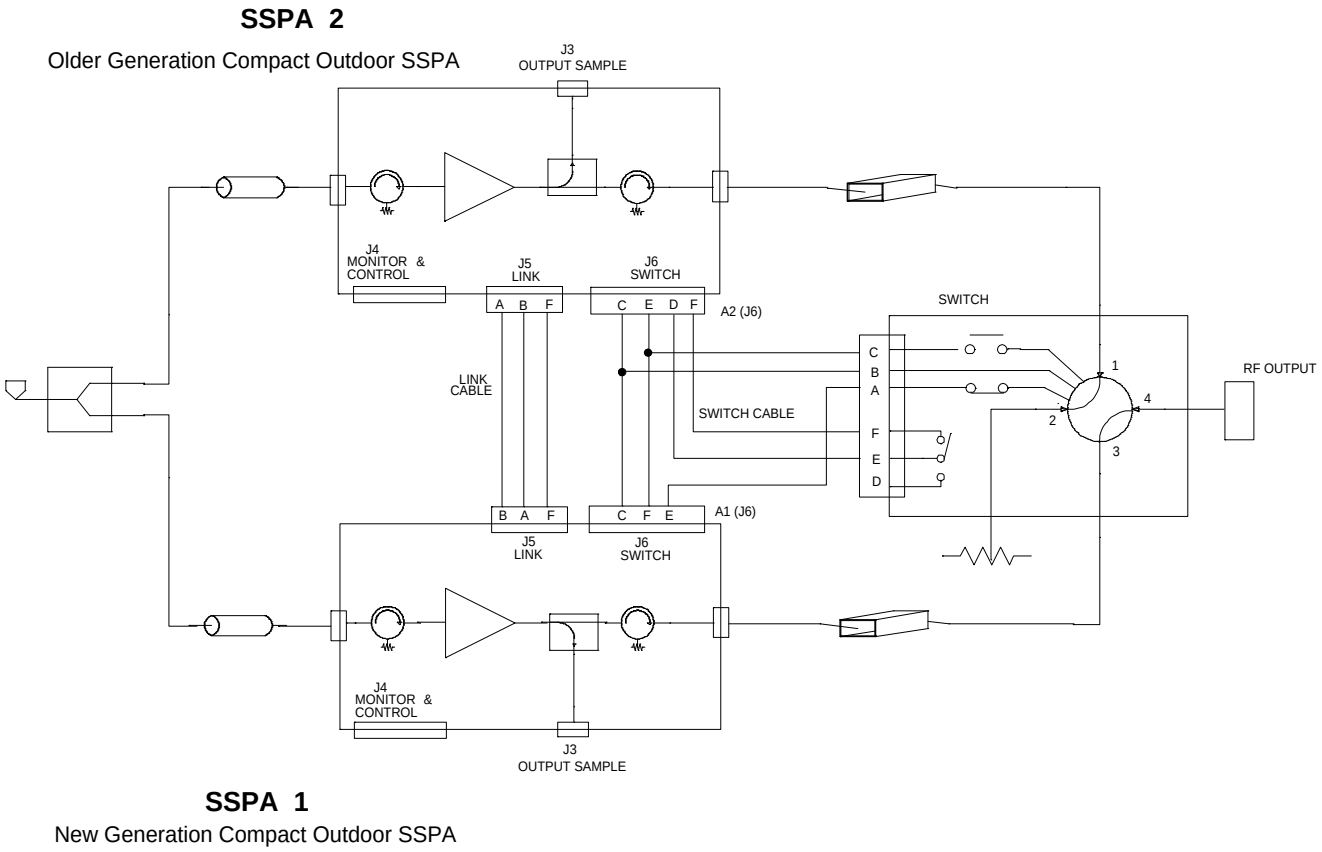

Figure B-1: Mixed Redundant System using New Generation and Original Compact Outdoor Amplifiers

Mixing Compact Outdoor SSPA with other manufacturer Amplifier

Configuring redundant systems with other manufacturers amplifiers can be achieved by using an external controller such as the Paradise Datacom RCP2-1100. The external controller is required because the internal controller in the Compact Outdoor Amplifier is specifically designed to operate with other Compact Outdoor SSPAs. The RCP2-1100 controller will control the 1:1 redundant system provided that the other manufacturers amplifier is equipped with a form A or form C summary alarm relay contact. Such a configuration is shown in the schematic below. The RCP2-1100 is a 1RU high remote controller capable of driving a waveguide switch that is located several hundred feet from the controller

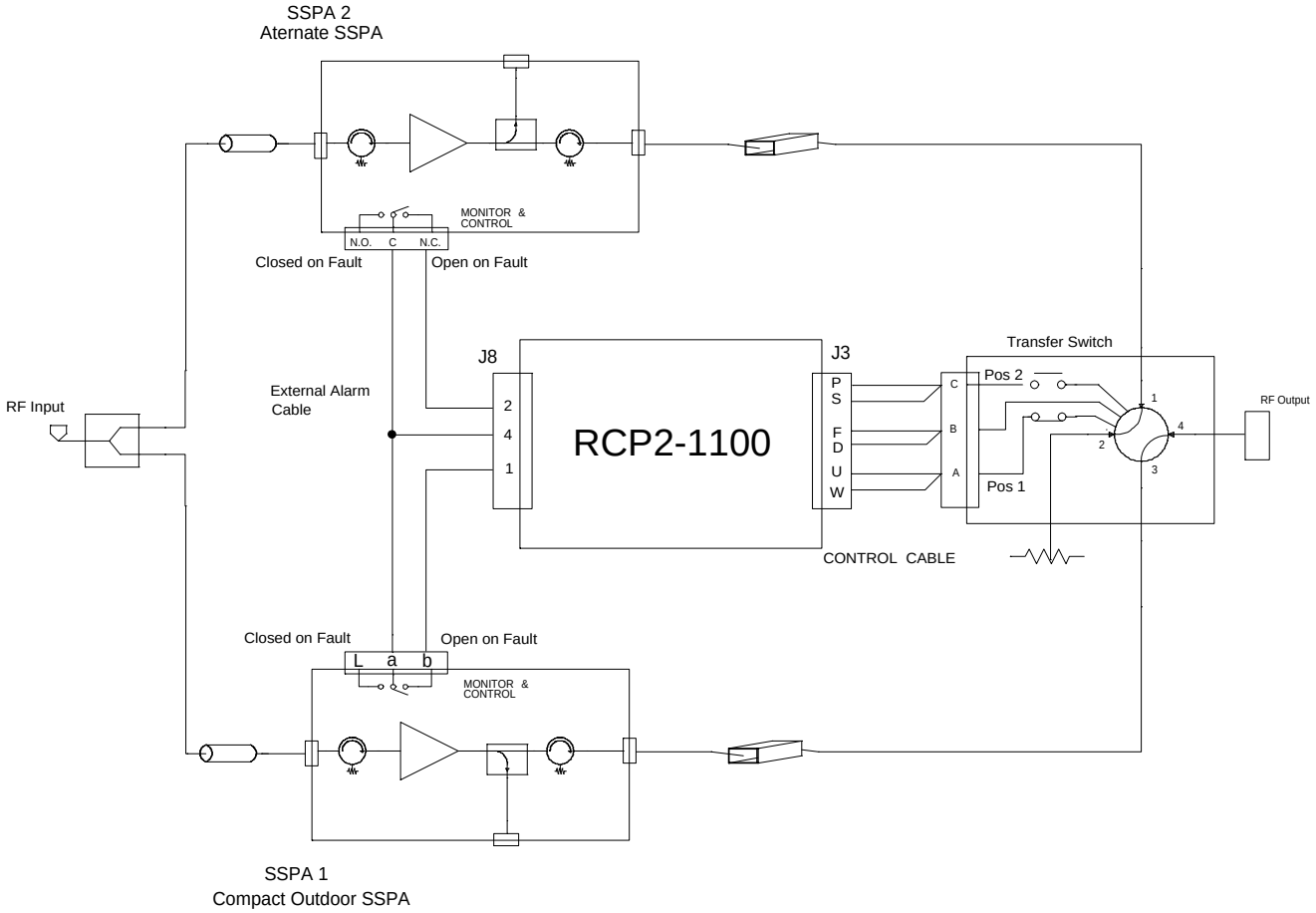

Figure B-2: Redundant System using RCP2-1100 Controller

Baud Select Lines on J4, Monitor & Control Connector

Pins j and e of M&C connector J4 allow the user to have some control over the serial interface, bypassing EEPROM settings for Protocol, Baud Rate or Network Address. This feature becomes important if the user accidentally selects the wrong protocol or baud rate of the SSPA and wants to revert the unit to a known state.

These pins have internal pull-ups and if left disconnected will remain in logic high state. The reverting function of the SSPA is active only on initial power-up. Any alterations to the pins' state after start-up will allow the SSPA to use internal EEPROM settings to select the baud rate and protocol. These pins also are used automatic addressing. This option will work with I/O board firmware levels of 3.50 or later. Do not attempt to activate this option on units with earlier firmware versions!

To revert an SSPA to a known interface state, complete the following steps:

1. Turn off the SSPA;
2. Establish wire jumpers to the M&C connector J4 according to the desired protocol selection (See Table C-1);
3. Turn on SSPA and remove the jumpers;
4. Connect to SSPA over serial protocol and select the desired settings for protocol and baud rate. Settings will take effect after next SSPA power-up.

Table C-1: Baud Rate and Protocol Reverting Options

Jumper 1	Jumper 2	Selected Protocol	Selected Baud Rate
j-d	e-V	Standard String Protocol (see Section 10)	9600
none	e-V	Standard String Protocol (see Section 10)	38400
j-d	none	Binary Protocol compatible with CO SSPA with serial number 100,001 - 199,999	38400
none	none	Settings last saved to EEPROM	EEPROM setting

To turn on automatic addressing:

1. Connect to the SSPA over serial interface;
2. Set the SSPA unique network address to 170 (Hex 0xAA)
3. Cycle the unit's power. The unit will start with default baud rate of 9600 and Standard String Protocol selection. Pins j and e now will determine the SSPA unique address (See Table C-2).

Table C-2: Unique Network Address Hardware Select †

Jumper 1	Jumper 2	SSPA unique address
j-d	e-V	1
j-d	none	2
none	e-V	3
none	none	4

† SSPA address in EEPROM must be selected to 0xAA in order to activate this option.

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VSAT BUC protocol support

In order to provide seamless integration with the legacy SierraCom VSAT BUC product line, compatible serial protocol was introduced to the CO SSPA protocol selection. This protocol is supported in I/O board firmware version 3.50 or better. In order to enable SierraCom protocol, connect to a SSPA unit over Standard String Protocol. Select the relevant option from System Settings Table 10-6 (data address 16). Cycle SSPA power. After power-up, unit will come up with new protocol selection.

Protocol Description

This manual provides only a short description of the VSAT BUC serial protocol, and covers common compatibility issues. For a full protocol description, refer to Paradise Datacom LLC document number 201410.

Serial Data Format

The serial data format is listed below. The SSPA should respond to any command within 50 msec. If there is no response in that time, the host computer should repeat the command.

Baud Rate	9600 bps
Data Bits	8
Parity	none
Stop Bits	1
Message Rate	1 every 40 msec
BUC Response Time	12 msec, typical
Maximum Response Time	40 msec

Power Up State

Original VSAT BUCs utilized one of two power-up modes: RF ON and RF OFF. The CO SSPA works differently – it powers up using the last saved state. In order to make the CO SSPA power up behavior similar to that of a VSAT BUC, extra functions were added to the Auxiliary I/O. To decouple CO SSPA style muting, an additional wire jumper between pins G and B has to be installed on the M&C connector, J5. Auxiliary logic has to be altered as well. See Table 10-6 Data Address 12. Select Startup in Low Z State for power up with RF ON state and Startup in High Z State for RF OFF power up. If Auxiliary logic is set to normal Auxiliary fault operation (Ignore, Logic Low, Logic High), the CO SSPA muting schema will be implemented and Aux fault becomes available for system usage.

Table D-1: Suggested Cable Wiring for ND Satcom SkyWAN modems

Connection	Signal description
B-G	Wire Jumper, Mute Control
E-F	Wire Jumper, to RS485 Data - line
T-U	Wire Jumper, to RS485 Data + line
V	Signal Ground (optional)

Table D-2: Packet Structure

Byte	Name	Description	Value
1	Address	Address of SSPA	0x01 to 0x0f
2	Command	Request Status Transmit on/off Change Address Set Carrier Frequency † Gain Adjust	0x01 0x02 0x03 0x04 0xFF
3	Data Byte 1	Not used if command = 0x01 ‡ Tx control if command = 0x02 New address if command = 0x03 Carrier Frequency if command = 0x04 Gain Adjust	0xAA 0 = Off, 1 = On 0x01 to 0x0f MSbyte 0x01
4	Data Byte 2	Not used if command = 0x01 ‡ Not used if command = 0x02 ‡ Not used if command = 0x03 ‡ Carrier Frequency if command = 0x04 Gain Level	0xAA 0xAA 0xAA LSbyte 0x01 to 0xF
5	Data Byte 3	Not Used ‡	0xAA
6	Data Byte 4	Not Used ‡	0xAA
7	Checksum	Algebraic sum of bytes 1 - 6	

† - Dummy command; will have no effect on SSPA operation;
‡ - don't care bytes; any value will be accepted as valid, as soon as checksum is correct.

Table D-3: Response Structure

Byte	Name	Description	Value
1	Address †	Address of BUC shifted left by 4	0x10 to 0xF0
2	Level Byte 1	MSbyte of Tx output power	-
3	Level Byte 2	LSbyte of Tx output power	-
4	Temperature	Temperature in ^{o}C ‡	-
5	Status Byte 1	Bit 0: Temperature out of range Bit 1: PLL out of lock Bit 2: Checksum Error Bit 3: Tx Status Bits 4-7: Power Class	1: fault, 0: normal 1: fault, 0: normal 1: error, 0: normal 1: Tx on, 0: Tx off 0x1 to 0xF
6	Status Byte 2	Bits 0 - 3: Not Used Bits 4 - 7: Software Version	0xA 0xF
7	Checksum	Algebraic sum of bytes 1 - 6	

† Addresses 1-15 only allowed. Make sure that SSPA unique address is within this range before switching to VSAT BUC emulation protocol. Default address of BUC is 0x01.
‡ CO SSPA will always display internal plate temperature. Unlike the BUC even if mute state is on, current temperature value will be reported.

Table D-4: Power Class Values†

Value	Power
0x1	2 watt
0x2	4 watt
0x3	5 watt
0x4	8 watt
0x5	10 watt
0x6	16 watt
0x7	20 watt
0x8	25 watt
0x9	40 watt
0xA	55/60 watt
0xB	30 watt
0xC	125 watt
0xD	80 watt
0xE	100 watt
0xF	170 watt

† Closest value of power class is reported; actual power level of the unit may differ.

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The following pages comprise the specification sheets for the Paradise Datacom Compact Outdoor Solid State Power Amplifiers:

S-Band, C-Band, X-Band or Ku-Band: Drawing Number **205485**
Ka-Band: Drawing Number **207151**

See the Paradise Datacom web site at http://www.paradisedata.com for the latest revision of these documents.

Also included are the Block Diagram, Schematic and Outline Drawing for the specific model ordered.

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